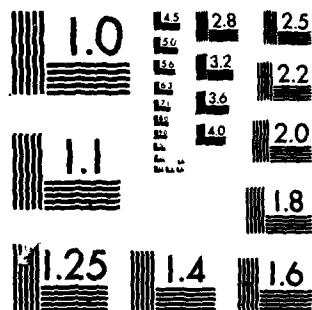


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discussions they generated; the bulk of the report consists of the papers themselves. A roster of participants' addresses and telephone numbers is included.

Papers represented the following agencies: Departments of Defense, Air Force, Army, Navy, and Labor; General Accounting Office; National Aeronautics and Space Administration; National Institute of Education; and National Science Foundation.

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PRODUCTIVITY PROGRAMS AND RESEARCH
IN U.S. GOVERNMENT AGENCIES

*Proceedings of a Symposium
held at
Arlington, Virginia*

June 27-28, 1983

EDITORS:

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December 1983

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Mrs. Carol Blair of the Smithsonian ably handled the many clerical details that preceded and followed the meeting. Mrs. Becky Graham, also of the Smithsonian, saw to the arrangements at the symposium site and shepherded this report through publication with her usual high standards and good sense.

Bert T. King

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Appendix A: Symposium Program

Appendix B: Roster of Symposium Participants

BACKGROUND

There has been an emerging recognition of a "productivity crisis" in the United States. A Bureau of Labor Statistics study (1981), for example, reports that the United States currently ranks sixth of seven leading industrial nations in productivity gain (output per man-hour). Further, its growth rate of productivity has declined from 3.2 percent in 1947-1966 to 0.8 percent in 1973-1979. Since 1980, the United States has actually experienced a negative productivity gain in the private sector.

This situation has led to a rapid expansion of articles, books, and public awareness of productivity and productivity improvement programs. Witness, for example, the public response to the following books on the topic: In Search of Excellence by Peters and Waterman (1982), Working Smarter by the editors of Fortune (1979), and Theory Z by Ouchi (1981). In 1981 President Reagan established the National Productivity Advisory Committee, which conducted a White House Conference on Productivity in September 1983. The objective of that conference was to develop recommendations for stimulating productivity growth and for promoting private sector initiatives in the productivity area.

While analysts consistently find a decline in United States productivity, they emphasize a great variety of different causes, including technological, capital investment, and human resource factors. This confusing state of affairs is partially due to the absence of adequate theories and conceptual frameworks by which to identify the causes of declined productivity growth and by the dearth of innovative research differentiating high-productivity organizations from less effective ones.

Productivity has also become a major concern for federal agencies and has taken on increased importance as the demand for services has increased faster than the tax revenues which support these services. Management in both the public and private sectors has increasingly turned to the behavioral sciences for solutions to the productivity crisis. The response has been to advocate and implement "quality of worklife" programs, job redesign, "quality circle" programs, increased employee participation, and the like, in an attempt to design organizations which are more congruent with the abilities, needs, and goals of employees. When properly implemented and accepted by both managers and employees, such programs can show significant improvement in costs, quality, and increased productivity.

In order to assess the state of productivity programs and research in U.S. Government agencies, the Office of Naval Research sponsored this symposium. It had several purposes: (a) to bring together researchers, sponsors, and users to exchange information on current federal R&D in productivity, (b) to identify research needs and priorities, and (c) to avoid duplication of effort. (Appendix A is the program for the meeting.)

Speakers were encouraged to present a brief summary of research executed in the past, a review of current work (with emphasis on the priorities in programmatic efforts and research), and a review of future plans. Each participant submitted an abstract of his/her paper. These are

included in this set of symposium proceedings, along with a summary of the main points of the discussion following each presentation. A number of other individuals from federal agencies having a high interest in productivity and productivity improvement programs were also invited to the symposium. (See Appendix B for a list of symposium participants.)

The symposium was held in the Marriott Key Bridge Hotel in Arlington, Virginia, June 27-28, 1983.

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Bureau of Labor Statistics, International Trade Administration, Department of Commerce (1981, September). International economic indicators. Washington: Author.

Fortune, Editors of (1979). Working smarter. New York: Viking.

Ouchi, W. G. (1981). Theory Z. New York: Avon.

Peters, T. J., & Waterman, R. H., Jr. (1982). In search of excellence. New York: Harper & Row.

HIGHLIGHTS

In speaker presentations and the discussions that followed, these main points emerged:^{*}

-- Productivity shortfalls are not exclusively economic problems. Rather, the issue of behavioral change is critical in that managers and workers need to be willing to do things differently. Likewise, our national pattern of education and training directly contributes to our productivity problems and is in need of major changes (Striner). Labor unions have not objected to productivity improvement per se, but they have resisted the introduction of change (Lunden).

-- Organizational characteristics which inhibit productivity are: a) policies which punish mistakes and do not reward achievement; b) tendencies to avoid accountability, to reorganize, to overcoordinate, and to put off decisions; c) preoccupation with short term results, which leads to excessive competition among individuals (Braunstein). A characteristic of American management is our emphasis on short term rewards, a practice that can only be counterproductive in the long run (Striner). To improve productivity, improve management--most problems are at that level. We know a lot about productivity problems and how to solve them. We don't know how to convince organizations that they need to change (Broedling).

-- Innovative management is an essential element of productivity improvement. But among the obstacles to innovation is a limited appreciation by science and technology decisionmakers of what the social and behavioral sciences can do for them. Management preoccupation with macroeconomics is a major obstacle to productivity improvement. Relatively little is known about the process of innovation, although there is a lot of folklore on the subject. Research on innovation has been hampered by difficulties in deciding on appropriate units of analysis. We need to do more controlled experiments in real time, using more robust methods and a systematic application of multidisciplinary approaches. Productivity research should be theory-driven (Tornatzky). We need ways to bridge the gap between research outcomes and implementation (Ginnett). Promising approaches to improving productivity are: a) better selection of workers, b) training, c) behavior modification, d) goal setting, e) group actions such as quality circles, f) better understanding of organizational culture and styles (King).

-- While personality factors and leadership styles have been shown to be important determinants of productivity, there appear to be no quick fixes; nor is there any obvious use to which such knowledge can be put (van Rijn, Tornatzky). Even though there is evidence that practices such as "productivity gain sharing" have beneficial effects, they should not be

^{*}Names in parentheses refer to the authors of papers in the main body of this report, and, in a few instances, to unpublished introductory remarks.

tested in work settings unless participating workers opt for such tests; moreover, a high approval rate, e.g., 75 percent, is desirable (Siciliano).

-- Some unresolved questions about productivity and education are: Can we measure the productivity of an educational institution and how it changes over time? What are the roles of economic and non-economic incentives in recruiting high quality teachers? Can teacher performance be improved with non-monetary incentives? (Dean). Teachers do not work well in isolation from one another; schools are workplaces that can, like other settings, foster a type of "collective enhancement" among workers. For example, it is known that when teachers discuss school matters with one another, their individual instructional outcomes improve (MacColl).

-- On the basis of a long term study of federal agencies, the Government Accounting Office concludes that three conditions are essential to productivity improvement: a) a non-adversary relationship between management and labor; b) a sharing of the benefits of productivity improvement; and c) a management style that is based on participation rather than top-to-bottom directiveness (Morgan).

-- There is very high-level concern in the Department of Defense regarding productivity improvement as a way to cope with increasing national security demands in the face of level or diminishing budgets (Powers). Productivity improvements in the Department of Defense are likely to come from research that addresses: a) whether an emphasis on quality leads to greater commitment; b) the nature of participative management in DOD; and c) optimal ways to introduce technological change (Powers). In the Navy, military and civilian personnel co-exist in a less than optimal relationship, a fact that undoubtedly affects productivity. This is an area that should be investigated; another is the high cost of implementing policy change; (for example, training people to administer the new merit pay system cost the Navy \$12 million) (Meletzke). The Navy would gain from adopting some of the private sector's productivity-enhancing techniques, particularly those having to do with human resources management. Incentive systems do improve productivity under the right conditions and if properly put in place and managed (Broedling). Critical unresolved issues in the Air Force include: a) an understanding of wartime needs and how to enhance wartime productivity (Weaver); b) development of an explanatory model of organizational productivity (Ballantine). Productivity improvement in military settings will have major implications for industry, and vice versa (Striner).

-- Productivity research should take these directions: a) more longitudinal research; b) an examination of processes as well as outputs; c) experimentation with new ways to organize work; d) new approaches to building trust, motivation, and participation; and e) the analysis of impediments to productivity. There is a dearth of robust theory dealing with productivity, particularly in nonindustrial settings. Measurement of group and organizational productivity is an unsolved problem. There is an absence of good productivity program evaluation (King). Other areas of great promise for R&D are: introducing change, innovation, breaking down management resistance, and, generally, understanding the barriers to change (Striner).

-- Other questions include: What measures are appropriate to the evaluation of productivity enhancement techniques? What budget and procurement practices inhibit productivity? What is the optimal proportion of individuals in an organization to be rewarded for outstanding performance? (Braunstein).

-- Strategies for maximizing the effects of productivity research should: a) emphasize action research, supplemented by measurement; b) tie organizational factors to bottom-line outcomes; c) aim at very large-scale interventions (Broedling).

-- An information-transfer system based on a good taxonomy of research-based knowledge about productivity would lead to immediate gains in productivity. Defense and the services are in a good position to develop such a taxonomy, and they should turn to the large corporations as resources (Striner).

-- Productivity researchers need a network for exchanging information that will lead, perhaps, to joint efforts. This symposium could lead to a more permanent community of researchers and facilitators of productivity in federal agencies. Such a move could bring about the exchange of research proposals and joint funding (Tornatzky, Lunden).

REGAINING THE LEAD IN PRODUCTIVITY GROWTH*

Herbert E. Striner
Kogod School of Business, American University

Since the late 1970s, there has been a crescendo of articles, books, and public pronouncements dealing with the emerging recognition of our "productivity problem." Certainly, since 1980, which marked the United States' third consecutive year of negative productivity gain in the private business sector, "mule psychology" had begun to work. Getting hit between the eyes by a 2x4 plank had at least gotten our attention! The question has ceased to be whether the U.S. is in trouble, but why--and what can be done about it.

Given our penchant for quantification, some of our economic savants have felt that unless the numbers were beyond question, and crystal clear in meaning, it would be difficult even to say we knew the causes. This sort of thinking was exemplified in an article that appeared in the New York Times on July 13, 1980. A former chairman of the President's Council of Economic Advisers, Dr. Herbert Stein, stated:

The basic but really more difficult problem is the slow-down in the growth of productivity. I keep insisting we don't know the causes. Many people say we do; I think we don't really know quantitatively.

Of course, I am not certain of what the speaker had in mind when he used the term "quantitatively." If he meant that we do not have a precision that justifies changing policies, I would have to disagree. When a patient has a temperature of 102 degrees, one need not have a thermometer calibrated to tenths of a degree in order to take appropriate medical action. And an economy with three years of negative productivity growth--as contrasted with the economies of France, West Germany, and Japan, whose comparable growth rates ran from positive 4 to 5 percent--is hardly a footrace that calls for stopwatch accuracy. On the other hand, for those interested in quantification, we do have productivity indexes. One need only look at the 443-page volume Measurement and Interpretation of Productivity, published in 1979 by the National Academy of Sciences, to see that, imperfect though our indexes and data may be, a sufficient body of information and data exists for the U.S. to take steps to regain a respectable growth rate in productivity.

The Complexity of the Problem

As most of us know, one never has enough information: the same is true of time and money. And yet we manage to perceive problems and deal with them in some fashion. In the case of productivity, we are dealing

* This keynote address originally appeared in National Productivity Review (Winter 1981-82, pp. 5-11), from which it is reprinted.

with so many factors that, if a firmer underpinning of data and information is required even to start, the situation is truly hopeless!

In the National Academy of Sciences study cited above, a vivid reminder of this complexity is neatly summed up by one sentence: "It is hard to imagine any use for a single measure of productivity." This is true if we are looking to a single measure as the basis for specific actions concerning increasing or decreasing investment in research and development (R&D), changing the nature of federal regulatory agencies, or recommending a new pattern of labor-management relationships. But it is not true if we want to get some sense of how well our economy generally compares with that of other nations in the ability to use our resources more efficiently each year.

To do this, we have to examine three problems relating to productivity. The first is a problem of perception: we must be open to understanding if we are to be able to act. The second problem concerns the various action items we must deal with in our efforts to affect productivity. And the third has to do with joining economic and noneconomic factors in order to develop an effective action model to enhance our productivity efforts.

Obstacles to Understanding

Before taking any steps to understand the nature of a problem, a mind has to be open to learning. Simple though this observation is, there has been a major lack of willingness on the part of many of our leaders in business, labor, and government to accept the fact that, if we are to increase productivity, we have to be open to change. In essence, we have to change our habits and philosophy concerning the ways in which we produce goods and services.

Productivity is certainly an economic problem, but it is also a behavior modification problem. When we talk about business not getting a fair hearing in Washington, D.C., we are really talking about our tradition of an adversarial relationship between government and business. The same is true when we talk about labor-management problems. When we talk about the use of quality control circles to affect industrial design or production processes, we are talking about an attack on our traditional theories of management and the security of our hierarchical system, at least for those at the upper part of the hierarchy. When we talk about increasing worker participation in the management process, both management and unions have unpleasant visceral reactions, but for different reasons. And it is difficult to develop an open discussion of the positive implications of these suggested changes because of the perceived threat of the negative implications.

Resistance to Change

In all of these situations, people are being asked to consider changes that modify what they are comfortable doing, to change relationships with

which they are familiar and which, they hope, will be sufficiently effective to help them regain the productivity edge. This will not be easy to accomplish. During the last decade or so, changes in social values, expectations about the quality of work life, and new patterns of family relationships dictate major changes in the ways in which people work together to produce our goods and services.

Getting our managers, CEOs, union leaders, and government officials to understand and accept this is a problem of behavior modification. We economists need lots of help from our colleagues in psychology. We certainly need to know that mere exhortation to produce more or work "smarter, not harder" will not do the trick. Any individual in the private or public sector who is serious about the productivity problem must start by getting people to be willing to change. Productivity grows out of new techniques, new relationships, new sources of help and information that we are willing to use. The fondly held image of ourselves as "number one" has a long list of worthy predecessors like Egypt, Greece, Rome, and Great Britain. That self-image may be our undoing.

Reluctance to Incorporating Foreign Ideologies

Resistance to looking at what has succeeded in Japanese industry has almost inevitably stemmed from ideological factors, not economic theory. All sorts of crutches have been used since the mid-1970s by U.S. managers, union leaders, and government officials to explain why our culture, organization, market systems, social philosophy, etc., prevent us from transferring to our economy what has been working so well in Japan and achieving the remarkably high levels of productivity gain in that country.

Of course, there are significant differences in the industrial, social, and governmental spheres of our two countries. But these differences have never been the real basis for our reluctance to use what is transferable. Indeed, the Japanese are quick to point out that most of what they have used to boost productivity came from the U.S. to begin with. We have not been willing to understand the nature of all of the factors that affect productivity and the necessity to develop policies to deal with these factors. To do that, we have to be willing to change some of our most closely held self-images as well as production and managerial processes.

The Twelve Critical Factors

There are twelve factors that must be understood and dealt with if we are to increase our rate of productivity gain: (1) Research and Development; (2) Promotion of innovation; (3) Institutional relationships and values; (4) Business saving and investment; (5) Personal saving and investment; (6) Natural resources development and substitution; (7) Government; (8) Worker quality and skills; (9) Production techniques and systems; (10) Management techniques and philosophy; (11) Performance information; and (12) Knowledge transfer. And we cannot choose to deal with them one at

a time. The productivity problem must be handled as a simultaneous equation. We like simpler approaches to the problems of our economy; however, the basis for many of our failures in dealing with such problems as inflation, unemployment, and lack of economic growth is this desire for simplicity. Just look at the standard prescription that either Democratic or Republican Councils of Economic Advisers offer for these problems. It is usually either monetary theory or fiscal theory.

Adam Smith, over 200 years ago, knew better. Indeed, he started his Wealth of Nations with an inquiry into the role of labor, a skilled work force, as a key factor in economic growth. The opening chapters of this "Bible" of economic philosophy are concerned with the aspect of economic growth he regarded as prime, but which is not mentioned in the development of our modern approaches to economic growth. More will be said about this in another section.

1. Research and Development. During the last decade, R&D and scientific resources in the U.S. have fallen behind those of the Japanese, French, and West Germans. Our ratio of R&D scientists and engineers to total labor force has dropped, while theirs has risen. Unless this trend is reversed, the U.S. will no longer be the preeminent technological nation in the world; the implications for the need to regain higher levels of productivity are obvious.

2. Promotion of innovation. Producing new knowledge and new products is only the beginning. Unless we are truly receptive to using these new ideas and new approaches, there will be no innovation. Most people and most organizations do not like upsetting "apple carts," but that is what innovation is all about.

3. Institutional relationships and values. Ideas about monopoly, labor versus management, or government versus business have produced an adversarial society. To achieve our national productivity goals, we must move in another direction that brings together common interests. Other countries have imported U.S. management techniques and used them well. We now have to import from these countries. The "not-invented-here" syndrome must not stand in our way.

4. Business savings and investment. Business savings must be stimulated: it is a critical source for new capital, R&D, and training. An adversarial "hang-up" in Congress and in our society in general regarding profits reflects an ignorance of the relationship between profits, investment, and productivity gains. Tax policy, as well as changes in social philosophy, must begin to reflect this.

5. Personal saving and investment. Unless we stimulate personal savings, there will continue to be an inadequate pool of funds in commercial banks for investment purposes. Business must support the use of new devices, many of which have already been tried in Europe, to stimulate higher savings by individuals. An increase in consumer savings must be seen by industry as a major source of investment funds for business. All dollars are homogeneous and interchangeable!

6. Natural resources development and substitution. Changing patterns of resource use have always been with us, and always will. The history of technology is the history of "running out of things" and substituting lower-cost alternatives and new technologies. Americans have to stop using OPEC and oil as a crutch! The Japanese, French, and Germans have paid the same prices for a barrel of oil, but their record on productivity and inflation has been better than ours. We have to use more of the only infinite natural resource that humanity has--its imagination.

7. Government. We must evolve a more rational perspective about how to use government to encourage productivity gains. It has been a key factor in the economy of every major industrial society since the 1930s. This fact will not change. What must change? Government must begin to understand the consequences of its actions on the economy and work more effectively with the private sector to achieve what we all want, a bigger pie with bigger slices for all segments of society.

8. Worker quality and skills. The work force is the key resource of every economy. Every country that has had a good productivity record recognizes this. The policy of investing in human resources has been a keystone in the productivity gains of Japan, West Germany, and France. Their labor force training and retraining programs have guaranteed a skilled labor force for their industrial base. The U.S. has to match this performance; we cannot continue to operate with large numbers in our labor force who have no skills and must subsist as "wards of the state." But beyond this, we must build a new, trusting, and sharing relationship between all workers, managing and nonmanaging. We must learn to use the intelligence of workers, not just their physical capabilities.

9. Production techniques and systems. Production techniques are always on their way to obsolescence. Therefore, we must adopt a continuous stance of assuming there is a better, lower-cost way to produce services and products. There is no formula for doing this. Hence, we have to rethink our basic approaches to how good we believe we are. It is tough being number one, but it is tougher when you drop to number two. Staying in the lead means never being self-satisfied or smug.

10. Management techniques and philosophy. Short-term gains that obscure long-term losses, discounting the competition, using crutches like "the Japanese are different," "high energy prices are killing us," or "the American worker is not comparable to the German or Japanese worker"--these are nothing more than camouflages. Sony in San Diego uses those American workers. The French pay as much as we do for oil. And the Japanese, with all their cultural differences, acknowledge that they imported their management techniques from us. The Japanese say that their management techniques are 95 percent like ours, but different in every major aspect.

Americans can compete effectively with the Japanese, but we have to leap ahead of them, not copy them. We must innovate. And we can. To do this, our management philosophy must return to a production focus. The end product of a business is a commodity or service, not a list of merger "scalps." Finance, marketing, and accounting are all there to help us

improve on our selling or market share position. Somewhere along the line we seem to have lost sight of this principle.

11. Performance information. We need to understand and use indexes of productivity. They tell us where we have been. But never confuse the thermometer with the treatment of the disease. Improving our indexes does not improve our productivity. We have used the problem of inadequate indexes as an excuse for not treating the disease. Remember, all countries use about the same index construction technique.

12. Knowledge transfer. Knowledge is all around us. But only the really bright people know how to use it or have a strategy for using it. Since the U.S. is lagging badly in R&D, we have a special need now for a strategy of utilizing and building on knowledge from other countries. In the same context, one industry must learn to apply knowledge from other industries. The not-invented-here syndrome can be more debilitating than we may want to admit. We had better become more honest about this; the cost of not using whatever is available, from wherever it is available, is prohibitive.

Areas of Immediate Change

In addition to understanding the critical factors necessary for productivity gain, changes must be made almost immediately in at least two areas: (1) the skills of the labor force, and (2) research and development.

Skills of the labor force. Since the industrial revolution of the mid-1800s, perennial pessimists have been cautioning that new technology must increase unemployment and provide no new alternative forms of work. History has proven the contrary. The real experience has been that an advanced technological society has an increasing need for new, advanced skills. The problem is that there must be a mechanism for continually upgrading the skills of the labor force as we move from one matrix of skills to another. As noted earlier, Japan, West Germany, and France have dealt with this problem. In Japan, the underlying assumption for so-called lifelong employment in the large firms is to retrain workers as new products call for new skills. In West Germany since the late 1960s, and in France since 1971, government funding has provided for the constant retraining and upgrading of between 1 and 2 percent of the total labor force. None of the so-called manpower programs in the U.S. is even close. Our efforts have funded training for only between 0.1 and 0.5 percent. A manpower policy that guarantees a skilled labor force is vital to our economy and absolutely necessary for any improvement in productivity.

Research and development. A second area for immediate action is research and development. During the last decade or so, our R&D growth rate and our availability of research scientists and engineers has fallen behind that of Japan, West Germany, and France. Every indicator, including patents filed in the U.S. and abroad, sustains the impression of an eroded base of R&D in U.S. industry. Universities and government share in this drop, which has significant long-term effects for applied and developmental research. Unless this trend is reversed, and speedily, our efforts to

regain higher productivity levels will be largely frustrated. I say "largely," because there is one way to get a short-term "free ride," and that is by developing an effective strategy for knowledge transfer. We are already doing this.

In a July 5, 1981, New York Times article, the point was made that U.S. companies are recruiting more and more scientists and engineers from countries in the Middle East, Asia, and South America to stem the shortage of technical professionals that became apparent in the mid-1970s and continues today. This phenomenon has relevance to the point made earlier concerning the need to train our labor force for our new needs. This applies to scientists and engineers as well.

In labor force training and in R&D, both the private and public sectors must be involved. But as of now, the public sector has been fantasizing about being able to leave it up to the private sector. Well, it just will not work. Since the 1860s, government, in one way or another, has been a mainstay in R&D and large-scale education and training. The problem is that government is like a yo-yo on these two issues and does not recognize the need for maintaining continuous involvement and remaining a source of investment.

Back in May 1958, at a conference on R&D held by the National Science Foundation, the late Dr. Sumner Slichter, Lamont Professor of Economics, Harvard University, stated the problem well when he observed,

By and large, the Government has shown a grossly inadequate appreciation of the importance of research to the community. Government research expenditures, it is true, are large and have been growing rapidly, but they have been forced mainly by military considerations. The crimes, first of Hitler and later of Russia, have forced our Government to do research that it lacked initiative and imagination to attempt Indeed, it is safe to say that there is no field where larger Government expenditures would produce as rich a return as greater outlays on research--and also on the necessary foundations for research, the education of talented people. (National Science Foundation, 1958, p. 117)

Lack of Government Support

We have a perfect example of what I am talking about in the areas of R&D and manpower training. With the exception of large, well-financed industrial firms, continuing support for basic research is a luxury for most companies. During periods of national crisis, when time was of the essence, government either had to do such research itself, or fund it via industrial laboratories or universities. In the 1860s, when there was an urgent need for more trained farmers, mechanics, and engineers for our industrial revolution, the major source of help was the federal government's establishment of land grant colleges, the A&M schools. And more recently, the sudden need for engineers and scientists in the Sputnik

period could only be met by a National Defense Education Act, turning on the spigots of the taxpayer's money to expand our science base.

The U.S. is in an economic crisis now, and government support for research has been cut. Funds to provide loans for students who could become a part of our needed expansion of scientists and engineers are also being cut. Yet our need for engineers is self-evident. In 1978, we graduated 14,000 electrical engineers from U.S. universities. This was slightly below what we produced in 1970. But Japan graduated 20,000 electrical engineers in 1978, up from 12,000 in 1970. And on the support base needed for a good, hands-on education in the sciences, we have the following situation. During 1980, Tokyo University added more computing power to its education programs than is currently in place at the ten leading universities in our country.

Conclusion

In summary, to deal with our lagging rate of productivity gain we must accept changes within ourselves first. We must understand that an effective economic model must operate in a social and cultural context.

If the U.S. is to deal with the problem of regaining an acceptable rate of productivity growth, the economic factors contained in the list of the twelve productivity factors must be considered along with noneconomic factors. For example, decision to invest in developing a more effective labor force and to foster a labor-management relationship based on a participatory, decision-making model are economic in one sense. But to arrive at such changes in a really fundamental sense, as the Germans and Japanese have, requires an appreciation of the key role of the worker, physically and intellectually, and of the need to utilize all the resources a person has to offer in a production process. This can be achieved only by replacing an adversarial relationship with one based on a philosophy of mutual respect and a sense of each person's worth as a team member.

Likewise, a more effective tax policy to stimulate capital investment is an economic factor. But, it can best be developed if business and government move away from an adversarial relationship to one of mutual planning for an investment strategy calculated to achieve a higher rate of productivity gain.

If productivity is a joint economic and noneconomic phenomenon, then we must learn to meld these factors in our thinking and planning as we try to deal with the problem.

Reference

National Science Foundation (1958), Proceedings of a Conference on Research and Development and Its Impact on the Economy (NSF-58-36). Washington, DC: Government Printing Office, 1958, p. 117.

RESEARCH ON INNOVATION IN THE NATIONAL SCIENCE FOUNDATION

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National Science Foundation

A link between productivity and technological innovation is generally conceded by analysts, but the process of innovation is not well understood, on either a conceptual or an empirical basis. Most approaches to understanding and having an impact on innovation have focused on "policy" macro-variables (tax policy, patenting, regulation R&D funding). A case can be made that these macrovariables succeed or fail at the level of the firm, and the process of innovation can best be understood at that level.

The Productivity Improvement Research Section (PIR) at the National Science Foundation (NSF) has taken that stance, and it conducts intramural studies and supports extramural research on social and organizational factors involved in technological innovation. The units of analyses employed include macrofactors operating in the external milieu of the firm, variables that describe organizational phenomena, work group factors, and individual variables. Moreover, the body of innovation inquiry is interdisciplinary in nature, and is (or ought to be) focused on real-time, longitudinal studies.

Four areas of emphasis in the PIR research agenda are described: a) research on the implementation of technology; b) university/industry technological transactions; c) small firm innovation; and d) management of innovation and innovative management. Examples of ongoing extramural and intramural studies in each area were provided.

It is argued that these areas of research are ones in which more knowledge could have major implications for innovation and productivity. These are potential points of "leverage" in which dissemination of research findings could have national significance. Obstacles to reaching this goal include the disaggregated nature of social/behavioral science itself, the limited appreciation of social/behavioral science among science and technology decisionmakers, and the continued preoccupation with macroeconomic solutions.

PRODUCTIVITY GAIN SHARING IN THE U.S. ARMY MATERIEL READINESS AND DEVELOPMENT COMMAND

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Introduction

In 1977 and 1978, the U.S. Army Materiel Readiness and Development Command (DARCOM), faced with increasing work requirements and diminishing manpower availability, organized a major effort to narrow the difference between its validated manpower requirements and its authorized strength. This initiative, known as the Resource Self-Help/Affordability Planning Effort (RESHAPE), incorporated various productivity-enhancing motivation techniques as vehicles to increase labor availability and productivity.

In 1979, a radical productivity-based incentive program was developed for testing at selected industrial installations. This program, then known as 'profit sharing,' was given initial testing in 1980 at the headquarters of the U.S. Army Missile Command in Huntsville, Alabama, in a data transcription unit and at Anniston Army Depot, Alabama, in the Sub-Assembly Branch, a unit which does total repairs on M-60 series tank engines and transmissions.

Results from this preliminary test were positive, but, in the opinion of DARCOM's top management, inconclusive. A decision was made in July 1981, to enlarge the test in terms of both duration and size. The then recently established Office of Productivity Management, Comptroller, Headquarters DARCOM, was given the project. In late October of that year, that office convened a productivity gain sharing (PGS) workshop to: (a) determine eligibility of volunteers desiring to participate in the enlarged test and (b) promulgate test site candidacy criteria.

In April 1983, after a brief but intense development cycle, staggered testing began with a termination date at close of FY 83. A decision of whether or not to adopt PGS as a permanent program is scheduled to follow shortly after testing ends.

Design Considerations

Site Selection

Test sites for PGS were voluntary but had to meet certain key criteria prior to their being approved for testing a 'gain sharing' concept in a public sector application. In view of the novelty of the venture, at least in the public sector, emphasis was placed on accountability, particularly inasmuch as we were dealing with public funds in an era when competition for these funds is high and prudent stewardship is demanded by various elements of our society.

Pay for Performance

Since PGS is based on the assumption that employees will work harder if provided an equitable monetary inducement, a system of measuring both the 'should take' and 'did take' times to produce a product or service is central to the accountability issue of any nonprofit based enterprise. The establishment of a work measurement system, integrated with its larger organization's goals, will dictate the rate at which a PGS program is installed as well as its subsequent credibility by measuring the 'bottom line,' which motivates many public managers. Effective cost tracking systems must also be in place to assist program designers in bottom line analyses. To simply increase production via monetary incentives is only half the answer. It must be done without an attendant increase in the unit cost of the product or service. Additionally, other factors may drive up the unit cost--which, without a reliable cost accounting/tracking system, might cause already heavily risk-burdened public managers to disavow the initiative. Care must be taken, however, to insure that the cost to develop such accounting systems is acceptable as a normal 'sunk cost' to the testing organization. The existence of both the work measurement and cost accounting systems can also serve to minimize possible mistrust between labor and management by providing an open, fair appraisal of cost and production.

Workload

The use of a PGS-type program should be predicated on several management needs. The criterion of workload is a prime determinant in this decision process. An organization must exhibit sufficient workload requirements to accommodate a 20, 30, or even greater percentage increase in production due to the provision of equitable monetary inducements to the workforce. Unlike the private sector, public organizations do not capture a greater share of the market with increased efficiency or economy of operation. They must rely on doing 'more for less' or hold cost increases to a level lower than inflation. Workload may express itself in several different forms such as back logs, high overtime usage, or, as in the case of DARCOM, unanswered manpower requirements. An inadequate workload situation can, understandably, cause a negative reaction among the workers who may perceive PGS as a management 'game' to eventually reduce staffing. Planners should consider holding in abeyance PGS tests or live programs when workload dips below anticipated output levels or else shift labor out of the area/unit in which PGS was installed to achieve a balance of workload and manhours, which provides an opportunity to workers for gain sharing.

Voluntary Participation

In developing the DARCOM PGS test program, employee participation was decided on at the onset. As PGS had the notion of teamwork and cooperation at its foundation, and particularly since most test organizations used work center or group (rather than individual) output measures, a strong commitment from labor was sought. Access to decisions on virtually all aspects

of the test plan (the establishment of labor performance standards, cost and other accounting policies and procedures, and the maximum amount to be shared--50 percent--were the only non-negotiable items) was encouraged. In view of the many interdependencies involved in semitechnical and technical work centers, improving social congruence among its constituents is a vital link in the overall productivity chain and one which PGS planners targeted at the onset. Ultimately, the decision to test in a given area should be left to a vote of the target participants, for to impose PGS on an organization will normally yield less than optimal results in the long run. The vote should reflect more than a simple majority. Although no yardstick is known, a 75 percent or better acceptance rate is desired.

Conclusion

Although DARCOM's PGS testing is still in its youth and drawing conclusions is premature, the enthusiasm and responsiveness of test participants and programmers is encouraging. Productivity has increased, in some cases substantially, and if implementation costs were amortized over several years, as is done with any capital investment, unit cost of production would drop to a level where investment and maintenance costs are substantially less than the value of increased productivity caused by PGS. As significant as these achievements are, the improvements brought on supporting subsystems (parts/workload forecasting, methods and standards accuracy, labor and production reporting, to name but a few) would alone appear sufficient cause to justify the initiative.

SOCIOTECHNICAL EVALUATION PROGRAM AT THE
CORPUS CHRISTI ARMY DEPOT: AN APPROACH TO IMPROVING
PRODUCTIVITY AND THE QUALITY OF WORKING LIFE

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This paper introduces and summarizes the Sociotechnical Evaluation Program (STEP) being conducted at the Corpus Christi Army Depot. The history, analyses, and design recommendations for organizational change are briefly described, followed by a discussion of the implementation to date and key issues relating to the conduct of this research.

Background

The Corpus Christi Army Depot (CCAD) consists of a civilian work force of about 4,000 employees who have as their primary mission the repair and overhaul of serviceable UH-1H helicopters in accordance with Army requirements. Due in part to its health as an organization, the stability of its work force and workload, and its critical role in a major weapon system, CCAD volunteered for and was selected by the Depot System Command as the site for a demonstration project for sociotechnical systems analysis.

Two outside consultants, under contract to DESCOM, provided the training and technical expertise required to conduct the sociotechnical analysis. The Army Research Institute (ARI) was invited to participate in the effort as an independent outside observer/recorder of the process and the outcomes. Additionally, ARI will conduct research to increase the understanding of the variables that lead to organizational success and that will facilitate the transfer of the sociotechnical evaluation approach to other settings.

Sociotechnical Analysis

The sociotechnical analysis approach is a participative management approach and, as implemented at CCAD, involved the establishment of a 12-member STEP Design Group consisting of representatives from all levels and departments of the Airframes Division of CCAD. The Airframes Division, consisting of about 900 employees, performs all the repair and overhaul associated with the frame or fuselage (as opposed to the engines and transmissions) of the UH-1H helicopter; and because it represents a key function at the Depot, it was selected as the focus of the sociotechnical analysis and intervention.

Sociotechnical analysis is conducted in five stages: (a) system scan, (b) technical system analysis, (c) analysis of key variances and their control, (d) sociosystem analysis, and (e) development of the recommendations for the joint optimization of the technical and sociosystems. Each stage of the analysis is conducted by the STEP Design Group, under the guidance of the two consultants.

The system scan looks at the Airframes Division and the Depot as a whole and analyzes its inputs, outputs, boundaries, and adaptations to and interactions with the environment. It is the identification and definition of the objectives of the organization within the context of the environment. A major outcome of this stage was the development of the CCAD Philosophy Statement. This statement: (a) affirms explicitly CCAD's commitment to improvement of performance and quality of working life, (b) acknowledges that the abilities, desires, and commitments of its personnel are one of its key resources, and (c) promises management that is honest, fair, and sensitive to the needs of the work force.

The technical system analysis identified five key unit operations involved in the transformation of inputs into outputs in the UH-1H overhaul system. Key variances (deviations from the norm) and their controls were identified for the Airframes Division. The key variances were in the areas of parts availability, quality of assembly, and timeliness of the workflow.

A sociosystem analysis of the work-related interactions among people within the Airframes Division was conducted by the STEP Design Group through interviews of about 400 employees. On the basis of this analysis, certain individual and group interactions were found to be suboptimal, and existing organizational boundaries were not always conducive to good communication. Although there were some employee frustrations, they were usually not due to dissatisfaction with the work. Rather, they reflected the strong desire of the CCAD employees to improve their work, and their inability to effect the necessary changes under the existing structure.

As a result of the sociotechnical analysis, twelve recommendations were developed and approved for implementation. These are shown in Table 1. The bulk of these recommendations involve organizational realignments to facilitate communication and cooperation. Deeply embedded within the recommendations is the requirement for training. This training ranges from simple role definition, to principles of supervision, to the technical knowledge required in the parts acquisition process.

Project Schedule and Progress to Date

The STEP project at CCAD started in April of 1982 with the award of the contract to the two outside consultants. The technical and sociosystem analyses and development of recommendations were essentially completed by September 1982. Another three months were required to prepare for implementation and to obtain the necessary authorizations for implementation. Implementation was formally begun in mid-January 1983 with a reorganization (involving 235 personnel actions) and the beginning of the personnel selection and promotion process required to fill the new positions created by the STEP intervention.

Currently (June 1983), implementation of STEP is progressing as planned, although the amount of training required is greater than initially envisioned and more time-consuming. Despite this slight delay, the training is highly valued and is considered a necessary and essential component for the success of the STEP program. The streamlining of the aircraft flow

TABLE 1
Recommendations for Joint Optimization

1. Create new Maintenance Verifier positions;
2. Transfer forecasting function from Production Planning and Control (PPC) to the Supply Directorate;
3. Transfer Pre-shop Analysis from PPC to the Quality Assurance Directorate;
4. Transfer Production Control from Airframes Division to PPC;
5. Transfer ASTORS (Automatic Storage and Retrieval System) from Airframes Division to PPC;
6. Realign work centers (shops);
7. Create new WG-2 positions to free mechanics from clean-up and aircraft movement duties;
8. Develop a mechanic certification program;
9. Acquire a hardware carousel for nonkitted (small) parts;
10. Provide supervisor/manager training;
11. Streamline aircraft flow through the work centers;
12. Reduce dead-end jobs.

(Recommendation 11) and acquisition of the hardware carousel (Recommendation 9) were determined to be economically infeasible to implement at this time, and a subsidiary recommendation to rotate mechanics through the parts storage and retrieval function was considered to be no longer relevant. On the other hand, an emerging recommendation for a supervisor "understudy" program is gaining support and is beginning to be implemented for supervisory positions where pending openings (e.g., due to retirements) are known in advance.

Lessons Learned and Challenges to be Faced

Although there are many lessons to be learned from a project such as this, a number of these emerge time and again:

1. Top management support and personal commitment are invaluable for the success of the project.
2. Outside consultants play a key role not only in providing the training and technical expertise required for the sociotechnical analysis, but also by acting as facilitators and buffers between organizational components working at suboptimal levels.
3. Communication and coordination at all levels must be vigorously maintained. Avoid "surprises."
4. Relevant experts should be consulted to the maximum extent possible during the development and implementation of recommendations.
5. The STEP Design Group should always strive to maintain a constructive task orientation and deal immediately and positively with any negative attitudes.
6. Recommendations should specifically identify the measures of quality and quantity they are intended to change. Mechanisms for implementation (or lack thereof) should be considered in the development of all recommendations.
7. Recommendations should be considered dynamic and evolving rather than fixed and rigid prescriptions to be implemented "as is."
8. Document all phases and aspects of the project.

Some challenges yet to be faced are:

1. Sustaining the momentum and enthusiasm generated by the implementation of STEP;
2. Identification of the measures and variables that will validly and reliably reflect the effectiveness of the intervention.
3. Dealing with the repercussions to change at the worker level.

Conclusion

It is expected that this project will serve as an important model in the application of sociotechnical systems analysis to a military civilian work force. It is hoped that the lessons learned at CCAD will permit a more ready transfer of sociotechnical analysis to other systems and that organizational variables can be identified to permit a more informed transfer of this procedure to other settings.

NASA'S EMERGING PRODUCTIVITY PROGRAM

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Over the last five years NASA's budget--considering inflation--has been relatively constant, and its manpower levels have actually decreased. Recognizing that severe budgetary and manpower constraints are likely to become the conditions under which we operate in the years ahead, our administrator, James Beggs, drawing on his corporation background, established increased productivity as a top NASA goal. NASA formed a Productivity Steering Committee to develop an agency-wide approach to productivity and quality. This attention would provide, in the long term, the best approach for R&D and the highest level of quality under the constraints of a constant work force and tighter budget. The chairman of this committee is the NASA administrator and the membership includes key headquarters administrators and all center directors.

NASA's agency-wide effort, formally established in March 1982, is focused on seven strategic goals and is decentralized in its implementation and centrally coordinated by the steering committee. While a director of productivity, David Braunstein, is focusing efforts, no centralized productivity staff is contemplated; instead, productivity coordinator networks and working groups have been formed at headquarters and the centers to begin specific initiatives for the seven goals. Under these goals several agency-wide tasks were initiated in January 1983; they include reducing paperwork, cutting procurement leadtime, increasing contractors' productivity, developing common administrative ADP, promoting office automation.

In particular, NASA will be focusing greater management emphasis on productivity through a two-day productivity seminar for all managers, and through its approach in measuring productivity at the branch level within the organization. In addition NASA is taking steps to increase white collar productivity with employee-participation programs such as NASA employee teams, designed after the quality circle concept, and a revitalized employee suggestion program.

As evidence of management's commitment to productivity, the agency recently published its eight top goals and one prominent one is to "establish NASA as a leader in the development and application of advanced technology and management practices which contribute to significant increases in both agency and national productivity."

OVERVIEW OF GAO'S WORK IN HUMAN RESOURCES AND DEFENSE PRODUCTIVITY

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GAO established the National Productivity Group (NPG) in 1977 to provide a focal point for its study of productivity issues. This group is continuing its work in human resources productivity, currently emphasizing productivity reviews in the Department of Defense and at defense contractors.

GAO's Past Work in Human Resources Productivity

Over the last six years, GAO has continually emphasized the need to consider the human factor in efforts to improve productivity. This emphasis has taken the form of reports, testimony, and several speeches by the Comptroller General. On September 9, 1981, for example, GAO testified before the House Science, Research and Technology Subcommittee that the "human resources of the organization are clearly at the heart of any productivity improvement program." This testimony concluded with our observation that actions to improve human resources productivity must include three basic elements:

- the development of a nonadversary relationship between management and labor,
- the sharing of the benefits of productivity improvement, and
- a thorough change in management style, based on trust, in which the traditional top-to-bottom form of decisionmaking is replaced with one based on participation.

Several GAO reports and studies contributed to this observation. These human resources reports, as well as almost all of GAO's past productivity work, fall into two broad areas: (1) evaluating internal Federal Government productivity and (2) assessing the Federal role in promoting private sector productivity improvements.

Examples of reports which involve internal Federal Government productivity include a report on the Federal incentive awards program, a report on ways to improve Federal management and use of productivity-based reward systems, a report on the use of quality control circles in the Federal Government, and a report on the productivity impact of joint Federal labor-management committees.

Reports which involve private sector productivity include a report on the Department of Labor's leadership role and a staff study on productivity sharing programs.

While none of these reports focused solely on defense productivity, some involved programs at defense agencies. All of the reports contributed to our emphasis on the importance of the human factor in productivity improvement.

GAO's New Focus on Reviewing Productivity in DOD and at its Contractors

Improving productivity in the Department of Defense, and at defense contractors, has become increasingly important to GAO and many others because of:

- (1) an expanding defense budget that has brought louder and louder calls from members of the Congress and the public for assurances that additional defense funds be spent efficiently, and
- (2) public announcement and comment by DOD officials on major efficiency and productivity initiatives they claim will avoid billions of dollars in costs.

In response to this environment, GAO established a revised long-range audit plan last year that specifically targets productivity issues in DOD and at defense contractors for attention.

Over the years, GAO has issued numerous reports which dealt indirectly with defense productivity issues. For example, past GAO reports have addressed consolidation of DOD functions, use of more efficient equipment, more streamlined procedures, work measurement standards and many other ideas that can increase DOD productivity.

Under our more focused approach, GAO's orientation to productivity issues at DOD differs in several key respects:

- First, we are systematically identifying all formal DOD productivity programs and evaluating their results.
- Second, we are attempting to determine whether those formal productivity programs are directed at optimum targets of opportunity.
- Third, we are continually searching for successful productivity techniques from other Federal agencies or the private sector which might work in the DOD environment.
- Fourth, we are interested in the kinds of organizational or policy changes that could make long-term, institutional changes in productivity enhancement.

Some Specific GAO Assignments Now Underway

As we review productivity improvement in DOD and at its contractors, we look at the subject from several perspectives. In the current

environment of debate over the defense budget, as discussed earlier, we will continue to look at the broad top-level DOD programs, such as the Acquisition Improvement Program. However, we are interested in many other perspectives, such as:

- How is each military service formally organized to improve productivity?
- What are the targets of opportunity for productivity improvement within individual services, programs or projects?
- How successful are specific techniques and disciplines--whether old or new--in enhancing productivity and reducing costs?

The National Productivity Group's work in DOD during the past several months has been heavily involved with two programs which are primarily intended to improve defense contractor productivity and to reduce defense acquisition costs. Neither of the programs is new, but both are receiving increased congressional attention. The programs are value engineering and manufacturing technology.

In addition to these programs which focus primarily on the impact of technology on productivity, we are continuing our work in the human resources area. Current plans call for a survey of DOD's human resource productivity programs including the Army's Organizational Effectiveness Program, the Navy's Organizational Development Program, and the Air Force's Job Enrichment Program. The survey would provide the groundwork for evaluating the effectiveness of these and other human resource productivity programs in DOD. Issues to be addressed include:

- Benefits of the programs compared to costs;
- Validity of reported program benefits, particularly quantified benefits;
- Management of the programs, including planning, monitoring, documenting, and evaluating program results;
- Transfer of human resource productivity techniques between services and between defense and civilian agencies;
- Linkage of these programs to other formal productivity programs such as productivity measurement and capital investment;
- Linkage of these programs to resource allocation decisions;
- Coordination with the Department of Labor, the Office of Personnel Management, and other organizations with leadership responsibilities or expertise in human resource productivity; and
- Priority of these programs within overall DOD plans or strategies for improving productivity.

Finally, because of the difficulty of establishing cause and effect relationships when evaluating specific productivity improvement techniques, we are currently testing a different approach. In our productivity management review of the Naval Undersea Warfare Engineering Station at Keyport, Washington, which follows a similar review at the Federal Energy Regulatory Commission, we have employed a bottom-up approach which first requires that we measure the total performance of the organization. Second, we identify and cost out specific areas of opportunity for productivity improvement. Finally, we identify and recommend specific management and organizational changes for productivity improvement. Some of these changes may require the use of various human resource productivity techniques and programs.

AIR FORCE HUMAN RESOURCES LABORATORY
MANPOWER AND PERSONNEL DIVISION PRODUCTIVITY RESEARCH

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Introduction

Productivity research at the Air Force Human Resources Laboratory Manpower and Personnel Division (AFHRL/MO) is guided by a model which asserts that productivity is a function of opportunity, capability, and motivation. This research applies behavioral science principles to productivity enhancement and measurement, with the work group as the level of analysis rather than the individual. The goal of this program is to provide technical methodologies which are usable to Air Force managers.

Past Research

Past research in productivity focused on enhancement and measurement. The enhancement effort resulted in six technical reports produced from 1971 through 1982 under the direction of Dr. Robert D. Pritchard, Professor of Industrial Psychology at the University of Houston. These primarily exploratory, laboratory-type investigations examined the effects of feedback, goal setting, and incentive systems on productivity. Results suggested that feedback, goal setting, and incentives substantially improve productivity, e.g., produce increases in output of up to 10 percent and decreases in error rates of up to 28 percent. Results were encouraging enough that AFHRL plans to conduct a full-scale field test of feedback, goal setting, and incentive systems in an operational Air Force setting. This field test is described under current research.

The measurement effort, under the direction of Dr. Thomas C. Tuttle, Director of the Maryland Center for Productivity and Quality of Working Life, resulted in three reports produced from 1979 through 1981. The first was a manager's guide to productivity improvement resources and programs (Tuttle, 1981a). This report describes 18 productivity and quality of working life (QWL) programs used in organizations in the Department of Defense and various Federal agencies, identifies selected resource materials useful to individuals in productivity and QWL programs, and lists the interests and services of a number of non-profit organizations whose goals are to facilitate productivity and QWL improvement. The second report was an annotated bibliography of 339 references on productivity measurement and enhancement (Tuttle, Wilkinson, Gatewood, & Lucke, 1981). The third report clarifies the meaning of organizational productivity as it applies to the Air Force, describes and critiques productivity measurement methods, and describes a procedure for generating measures of productivity in Air Force organizations where obvious measures do not exist (Tuttle, 1981b). This research suggests that productivity is a combination of efficiency (the ratio of inputs to outputs) and effectiveness (the extent to which output productivity is concerned with both "doing things right" (efficiency) and

"doing the right things" (effectiveness). This report recommends the Methodology for Generating Efficiency and Effectiveness Measures (MGEEM) as a procedure for measuring productivity when engineered criteria are unavailable. The MGEEM requires a measurement coordinator who brings together the commander of a target organization and his or her immediate subordinates, who, through a structured group technique, answer the question, "What does the Air Force pay this organization to do?"

Answers to this question are called key results areas (KRAs). Next, a second group is formed of the commander's immediate subordinates and their immediate subordinates. In a structured group process, this group answers the question, "What does the commander need to know to have adequate information on each KRA?" The resulting information is called an indicator, and its source is identified. For instance, a KRA might be safety, its indicator might be current injuries and past injuries, and its source might be an Air Force form. A simulated use of the MGEEM at an Air Force base led to a field test of the procedure. This field test is discussed under current research.

Current Research

Current research in productivity continues the focus on enhancement and measurement. One enhancement effort, under the direction of Dr. Robert Pritchard, is an operational field test and evaluation of the exploratory work conducted between 1971 and 1982 which developed concepts and principles about the effects of feedback, goal setting, and incentives on productivity. However, this effort is more than just a field test of past research because more complex jobs requiring interaction will be studied and the criteria will be group productivity, not individual performance. The 40-month field test is being conducted in three organizations at an Air Force base. The test will develop productivity criteria; develop and collect baseline data; design and implement feedback, goal setting, and incentive systems; develop a non-monetary incentive taxonomy; and determine the net and incremental effects of these interventions on productivity. The project will result in practical manuals to guide Air Force managers in the use of feedback, goal setting, and incentive systems.

A second enhancement effort, by Dr. Lawrence Peters of Southern Illinois University and Dr. Edward J. O'Connor of the University of Texas at Dallas, is a study of performance relevant situational constraints. This research is directed at identifying the specific inhibitors to performance in Air Force work settings and analyzing their effects on worker motivation and behavior. The work will develop a taxonomy of situational constraint dimensions and develop and validate a detailed survey instrument to measure the existence of situational constraints in Air Force jobs. This instrument will be used to collect constraint data to serve as predictors of affective and behavioral criteria.

The measurement effort, under the direction of Dr. Thomas C. Tuttle, is a field test and evaluation of the MGEEM in three functional areas--administration, propulsion maintenance, and weather--at 11 Air Force bases. Preliminary results show that the MGEEM provides a usable number of

indicators, although it appears to develop a much larger percentage of effectiveness as opposed to efficiency indicators. The MGEEM process is very acceptable to participants and is cost-effective to implement since most of the indicators have relatively low consistency across similar organizations. This project will suggest a modification to the MGEEM to improve indicator consistency across similar organizations.

Unresolved Questions

Scientists who study productivity at AFHRL/MO see three broad areas of unresolved questions and problems which may be amenable to solution by research. First, there is need to further develop measures of organizational productivity criteria. Having adequate measures of organizational productivity criteria is important not only to assess the status of productivity but to evaluate the impact of enhancement techniques. To be useful, such criteria must be reliable and have consensual validity among people in organizations studied. There are a number of unresolved questions about the present techniques for generating productivity criteria. Among these is why KRAs and indicators are not more consistent across similar organizations. It may be that the MGEEM methodology itself creates a lack of similarity. Another problem is how to aggregate KRAs to provide an overall index of productivity for a given type of organization. The solution to this problem may come from the use of various consensus-seeking procedures for aggregating KRAs, such as judgment analysis or a Delphi process. Another question results from the fact that the MGEEM produced more effectiveness than efficiency indicators. What factors, such as organizational level, are related to the disproportionate production by the MGEEM of one type of indicator over the other?

The second problem area involves the development of a model of the determinants of organizational productivity. Assuming a satisfactory refinement of organizational productivity criteria, such a model could be defined by a series of equations specific to similar organizational types in which predictors would include individual (e.g., aptitude and learning time), group (e.g., style of supervisor and time allocation) and organizational (e.g., personnel staffing and technological change) characteristics. The importance of a model which specifies the predictive relationship between such salient factors and productivity can not be understated. Such a model would increase our understanding of how the complex array of factors influences productivity and thereby permit the identification of ways to improve productivity.

The third problem area involves issues related to the utility in wartime situations of knowledge about organizational productivity developed in peacetime. There is no doubt that many of the functions accomplished by Air Force units in peacetime are similar to what those units would be doing in a deployed or combatant situation; for example, launching and recovering aircraft, repairing components, delivering fuel, and procuring and distributing supplies. Discovering and implementing improved ways of performing these peacetime functions will both enhance their effectiveness in wartime and free resources for use in improving readiness in other areas. On the other hand, there may be functions of Air Force units which undergo

substantial change between their peacetime and deployed or combatant posture. In addition, personnel, organizational, and situational factors which are relatively unimportant in peacetime may dramatically influence productivity in wartime. Organizational or situational differences for wartime scenarios must be identified to understand the differential effects of productivity measurement and enhancement between peacetime and wartime postures. For example, deployment of certain units to a combat zone may involve organization restructuring and assignment of personnel to jobs different from those performed during peacetime. Only when such factors and the relationship between peacetime and wartime productivity measurement and enhancement are known can realistic improvement to combat readiness be realized.

In addition, there is the potential pitfall of relying on intermediate or surrogate productivity measures. For instance, a manager could make a decision designed to improve productivity as portrayed by an intermediate indicator (such as number of supply transactions per input) that would actually decrease overall combat readiness. Thus, we are forced to rely on surrogate and/or intermediate measures, and are faced with the possibility of making good microlevel decisions in peacetime which might have an adverse effect on readiness. Efforts to improve productivity in peacetime must guard against this possibility. To avoid this pitfall, a better understanding of the relationship between productivity measurement and enhancement in peacetime and wartime environments is required.

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PROGRAMS, PROBLEMS AND POTENTIAL RESEARCH
IN THE U.S. AIR FORCE*

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Introduction

While the U.S. Air Force is currently involved in both productivity research and ongoing programs for productivity enhancement, this discussion focuses only upon the latter while the former topic has been discussed by my colleagues from the Air Force Human Resources Laboratory. Furthermore, these comments will not attempt to cover in depth all enhancement programs but instead will concentrate on those which employ behavioral science principles and techniques. It is important to note that this restriction eliminates from further discussion two programs which have contributed most measurably to labor productivity enhancement. Although these programs, Fast Payback Capital Investment Program (FASCAP) and Productivity Investment Fund (PIF), achieve productivity enhancement primarily through capital/labor substitutions, they are unquestionably the best documented and centrally managed Air Force productivity efforts to date.

The data from which these comments evolved were collected in support of a joint service effort conceived by researchers at the Navy Personnel Research and Development Center (NPRDC). This effort is an attempt to collect and discuss productivity enhancement efforts in the military which use behavioral science approaches such as quality circles, job enrichment, performance based incentives, sociotechnical systems, etc. At the outset the task seemed relatively straightforward, since the author had personal knowledge concerning three of the four suggested programs. It soon appeared to be a relatively false sense of ease, since it became apparent that these sorts of programs are not centrally managed or tracked. However, there is an established network of productivity principals throughout the Air Force who, theoretically, should be able to supply additional and current information. It was in this spirit that letters were sent to these principals and others who may have personal knowledge of behavioral science activities. The letters explained our interest and asked for their knowledge of any relevant programs having occurred within the last ten years. To add to the richness of the effort, personal interviews were scheduled with appropriate Air Staff officers and civilian researchers who might contribute their insights, such as Hackman, Powell, Vroom, Berg, and Tuttle, to name but a few.

The content of the replies, and the discussions, have led to this presentation. Specifically, this abstract will briefly present the outcome of the solicitation and a discussion of their nature. These inputs have resulted in the evolution of three areas or opportunities for further study

*The opinions expressed in this paper are those of the author and do not necessarily reflect official policy of the U.S. Air Force.

and research. While the three areas are not mutually exclusive and arguments for considerable overlap have merit, they will be presented separately to gain the advantage of clarity and structure.

Results of the Request for Input

Replies were received from eleven major commands or separate agencies, but the variance and range in number of programs submitted was quite surprising. The total number of behavioral science efforts for the last ten years reported was 29, but the number reported by each command ranged from zero to twelve with a mean of 2.6, a median of 1, and a standard deviation of 3.2--a rather skewed distribution. The use of quality circles was the most frequently reported program, followed by job enrichment (in various forms). The quality of program conceptualization, control, and measurement ranged from nearly none to extensive, with the Tactical Air Command's Combat Oriented Maintenance Organization (COMO) and Combat Oriented Supply Organization (COSO) (the closest to a sociotechnical program) and the Leadership and Management Development Center's (LMDC's) Management Consultation programs as two of the better examples. While discussion of these and other programs will be possible during the symposium, the intent here is not to focus on any individual program or input but on the data as a whole.

The data suggest a rather wide range of activities considered as meeting the criteria of behavioral science programs which enhance productivity. It is apparent from reading the inputs that whether or not the criterion or criteria is/are satisfied is a function not only of the program per se but also of the perceiver. It seems that behavioral science efforts in the Air Force are present or absent depending upon the lenses through which the respondent views the world. A second characteristic of the data also emerges. While some programs that were unknown to this author were reported, other programs known by the author to fully meet the required criteria were not reported by the respondents. This leads one to ask the question posed most notably in the well-known Johari window. Namely, how many programs in the Air Force are yet unknown to both this author and the respondents. These omissions are even more conspicuous if one considers additional and independent data sources. One example would be the Manager's Guide to Productivity Improvement Resources and Programs, which was compiled and written by Tuttle (1981) and published by the Air Force Human Resources Laboratory (AFHRL), which listed many programs found in the Air Force but not mentioned by productivity principals at this time. Another would be the compilation of organizational development efforts in existence throughout the Air Force, published by the Director of Personnel Plans (Gregory, 1979) and used as the basis for Gregory's American Psychological Association presentation of the same subject. While not all of these reported efforts would stand up under an academic evaluation of organizational development, of the 78 programs submitted, 48 specifically addressed improved effectiveness or efficiency as desired outcome variables. Many of these programs met all the requirements for submission under this current effort, yet they were not reported.

How then may we begin to explain these wide variations and omissions? Three possible (but as yet unresearched) hypotheses may be fruitful in searching for an understanding. It seems unlikely that any difficulties are attributable to lack of effort or any nefarious attempts to disguise or hide programs. Rather, these are hypotheses one might use in any realm of program study. First is the problem of knowledge. In terms of knowledge development, the Air Force has only had a formal productivity structure since 1979. This rather neonate organization should not be expected then to have amassed sufficient corporate memory to recall programs that may have been functional prior to their birth--in their pre-history, to use Sarason's terms. Nor would this function, which is localized within the management engineering specialty arena, be expected to have an extensive knowledge of behavioral science. As noted earlier, the knowledge one brings to a task helps to define the lens through which the world is viewed. One's lack of behavioral science filters can impact the impressions of programs among both practitioners and observers. Similarly, the lack of an integrating network between various disciplines would contribute to limited knowledge. As will be discussed later, this decoupling may have continuing consequences if behavioral science and productivity are to endure in a supportive fashion.

The bounded or limited knowledge relates to a second hypothesis. This suggested arena recurs throughout the literature as well as in field application. It is the unresolved problem of definition. What is productivity? Today's Air Force definition incorporates both quantity and quality; efficiency and effectiveness; doing things right and doing the right things. But this definition is relatively new, and the original focus on efficiency is often carried over as the predominant theme. Improvements in effectiveness are sometimes ignored even when they may be quite measurable. A second definitional problem is that of "behavioral science." While most academicians could probably arrive at a consensus operational definition, it is not at all clear from the data here that the surveyed productivity principals in the operational Air Force are unified on this point.

Finally, measurement seems to be a potential hypothesis or area of ongoing difficulty. While many have argued that labor productivity has poorly-operationalized terms in both numerator and denominator, it seems to be far more precise than other measures. While definitions and knowledge may be areas in which operational managers have limitations, they are often keenly aware of the difficulty of measurement. This problem is only exacerbated when one adds quality as an issue for measurement. Various Air Force examples in support of this claim are available. Fortunately, the research by Tuttle in this area (as described in the Weaver and Ballentine paper) seems a definite step forward.

These are only possible hypotheses to explain the variations and omissions in the current data collections. The major effort should focus on much broader and more ubiquitous potentials for needed research. While there are undoubtedly many, the interviews and informal discussions with various faculty members have resulted in three areas which would be helpful. These are: (a) organizational structure, (b) implementation, and (c)

issues of philosophy. While each of these could result in a full scale research proposal, they will only be highlighted here, with emphasis on unanswered questions.

Organizational Structure

Air Force Regulation 25-3 defines the responsibilities of at least 15 levels ranging from the Assistant Secretary of the Air Force for Financial Management down through major air commands, yet the organizational structure for productivity enhancement using behavioral science research, development, implementation, and measurement remains unclear. There are structures for behavioral science research and structures for productivity enhancement, but the integrating mechanism necessary for implementation is not well defined. Rather there are various agencies and levels of organizations responsible for these programs. While this has resulted in a lack of integration, it has provided a framework for observing organizational intra- and inter-actions. In some manners, the Air Force seems to mirror the larger context of productivity, particularly in its diversity. For example, if one is to attempt a comprehensive literature review on the subject of productivity, such diverse sources as the National Productivity Review, the Journal of Economic Literature, the Administrative Science Quarterly, the Journal of Applied Psychology, and the American Psychologist must be considered, merely as a starting point.

There seems to be a distinct boundary in the Air Force between those who measure and track productivity and those who would be considered behavioral scientists. Clearly, those responsible for measurement are centrally located in the management engineering area. Behavioral scientists are not as clearly specialized or localized. Contracted research is the responsibility of AFHRL and the Office of Scientific Research (OSR). Both the Air Force Institute of Technology (AFIT) and the U.S. Air Force Academy (USAFA) have conducted research and been involved with implementation, as has LMDC. But there appears to be no agency comparable to the Army's organizational effectiveness program (and its relationship with the Army Research Institute) or the Navy Personnel R&D Center (and its relationship with the Office of Naval Research) for centralization and continuity. Furthermore, there is no assurance (and often explicit denial) that one area will understand what the other is doing.

Another structural issue that has yet to be resolved is the current location of the productivity enhancement function. Not only are management engineering personnel often responsible for measuring and tracking productivity gains, but they are also responsible for the establishment of manpower standards. As noted in the 1980 Air Force Productivity Symposium (Short, 1981), this places the operational manager in a difficult position, because the same people who record and measure productivity gains and the resultant man-hour savings also reduce the manpower available to perform the task. If Cyert and March's concept (1963) of organizational "slack" has merit, it does not take much imagination to predict some potential outcomes under these conditions.

A final structural question involves the degree of centralization or decentralization desired for effective implementation. There are obviously differing opinions even within functions. FASCAP and PIF are highly centralized as a cursory review of AFR 25-3 will suggest. On the other hand, behavioral science efforts are highly decentralized. Whether this has been a result of the scarcity of resources or rather a failure to consider the issues of implementation is unknown. But at least one anecdotal illustration of the varied impression of the Buckstop Program would indicate that there are unresolved issues remaining. Perhaps the knowledge of the organizational theorists regarding attempts to mix structural designs across differing technologies could be adapted to this problem and applied. Perhaps trying to implement a decentralized program in a highly structured organization is not the most profitable approach. Perhaps a review of the demise of programs such as job enrichment would help answer some of these questions. At any rate, the entire area of organizational structure would seem to be ripe for study. It is also of direct consequence for the next area of inquiry.

Implementation

Certainly the question of program implementation, as mentioned above, is not clear in the Air Force. Who is responsible for implementation? Does the person or agency responsible have access to the necessary skills for behavioral science productivity enhancement? At which level should they be attached to gain maximum effectiveness? How do we link research and operational implementation most effectively? All these are questions worthy of continued research but they are merely an initial level. A more stimulating question relates to the implementation of measurement itself. At least two sub-areas are worth examination. The first involves the concept of linking. At what point do we say we are productive? Are we really enhancing productivity if we save 20 man-hours/month (which we measure) while, at the same time, possibly increasing attrition and absenteeism (which we may not measure)? Our tendency has been to examine productivity enhancement in the short run, often within six months or a year. Yet considerable behavioral science research dating back at least to the Hawthorne studies has shown that short term analysis may or may not be correct. On the one hand, short term measurement may be unduly influenced by the change process rather than the change, leading to false positives. On the other hand, short term measurement may miss the adaptive and constructive benefits noted in some long term behavioral science efforts. We may be focusing our efforts on that which Abernathy and Hayes have suggested may lead to our decline. Parallel to this and the referenced work of Tuttle is a related aspect of measurement particularly for the military: That is the issue of ultimate criteria for military effectiveness. While questions of word processing improvement and administrative processing efficiencies should not be ignored, the ultimate questions of military effectiveness and efficacy have perhaps received too little attention. Nor will they be easy to answer!

The second sub-area is one which I have labeled the iatrogenic effects of measurement. Certainly any measurement system has flaws. But what are

the consequences upon productivity of the measurement itself? What are the consequences upon those people who are the subjects of our measurement? There is some indication from the Orthodox Job Enrichment experience of AFLC that measurement may influence a program. There is also evidence that secondary measurement (that is, measurement not originally planned as part of the intervention but initiated separately) may, in fact, be a separate intervention resulting in its own consequences. The best intentioned programs may suffer this fate. But iatrogenics goes even further. If we implement a rigorous measurement program, what are the unintended consequences? Argyris suggests some serious unintended consequences of rigorous research in his article of the same name. If those consequences can be extrapolated to behavioral science productivity efforts, we may find ourselves in a rather paradoxical paradigm.

Philosophies

This final area is related to the other two, both directly and indirectly. Some may consider this an area too ethereal to warrant study while others could argue that it is the foundation of other problems. While it may not be an area of direct concern for those involved only in implementation, it does seem a worthy topic for researchers with ultimate consequences for everyone. The relationship between behavioral science theory and productivity is not clear. While research such as published by Katzell, Biesnstock, and Faerstein (1977), Guzzo and Bondy (1983), and Katzell and Guzzo (1983), unquestionably suggests an overlap between that which is behavioral science and that which is productivity, the magnitude of that overlap is unclear.

If one considers the roots of the two traditions, some variance is possibly suggested. One could suggest that the roots of productivity flow from that which we now call scientific management, or Taylorism. Likewise, much of what is included in the behavioral science realm has its roots in the human relations school. (Whether one accepts the traditional arguments of Roethlisberger and Dickson (1939) and Franke and Kaul (1978) or the radical review of Carey makes little difference for the sake of this argument.) These different backgrounds might suggest that measuring "manhours saved" has little to do with behavioral science in a fundamental sense. The question one must then ask is, "Where are we today?" Are we continuing to diverge from that original division or are we beginning to merge, either as a whole or perhaps through the emergence of specialties like organizational behavior?

If neither of these alternatives seems to resolve the difficulty, is it not possible that the old models are outdated? This would suggest a more radical approach such as was presented by Stanley M. Davis of Boston University (1983, spring) in a colloquium at Yale University. Perhaps the difficulties we are encountering are similar to those encountered by the new industrialists who attempted to see themselves through the models of agricultural society that preceded them. Perhaps the productivity models of the industrial age are not the most appropriate tools to measure effectiveness in an age of services and information.

As is the norm, research poses more questions than answers. That seems to be unusually so in this effort. It is hoped that, if nothing else, these questions may prove to be a catalyst for further symposium discussion.

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PRODUCTIVITY RELATED RESEARCH IN THE LABOR-MANAGEMENT SERVICES ADMINISTRATION

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There are two programs of productivity related research in the Department of Labor, one in the Bureau of Labor Statistics (BLS), and the other in the Labor-Management Services Administration (LMSA).

The BLS program* deals mainly with data collection and productivity measurement, and in one respect, concerns itself with social and behavioral issues; namely, the Bureau's industry technological studies briefly note collective bargaining provisions designed to ease the impact of technological change upon workers, but they center on productive resources and their impact upon employment, skill levels, training and occupational requirements. Consequently this paper will concentrate on the LMSA program.

The LMSA program is far more modest than the Bureau's. But it is firmly focused on workers and the workplace and despite a decade of intermittent involvement with productivity issues, can claim to be the new boy on the block.

Until recently, productivity and productivity improvement have been peripheral to LMSA's interests. Research functioned to meet the needs of the Assistant Secretary in his dual role as chief adviser to the Secretary of Labor on labor-management relations and as administrator of the Labor-Management Reporting and Disclosure Act. Research priorities tended to parallel shifting interests in the industrial relations community and was designed to keep LMSA's finger on the pulse of labor-management relations and to help practitioners.

LMSA initially turned to productivity in 1973 through its primary interest in public sector labor relations, then a new and growing area. It supplied minor support to an action-research project funded by other agencies involving Nassau County, New York and the Civil Service Employees Association which were seeking to improve productivity in municipal service

*Although the BLS was not represented in the conference, we feel that it is important to provide a brief description of productivity-related work of that agency. The BLS publishes indexes of labor productivity and compensation per hour, unit labor cost, and related measures for broad economic sectors. For several years, the principal effort to measure the productivity of agencies in the Federal government has been the BLS program to develop labor productivity indexes for all government agencies with 200 or more employees. The program currently obtains data and develops measures for organizational units representing about 64 percent of Federal employment. The BLS is also developing approaches to overcoming conceptual problems in productivity measurement. Further information concerning indexes published can be obtained by writing the Division of Industry Productivity Studies, Bureau of Labor Statistics, Washington, D.C. 20212.

through the bargaining process. In 1974, its interest raised by its modest involvement in Nassau County, LMSA broadened its horizons to study productivity improvement incentive programs in five cities. The contractor, The Urban Institute, published a widely disseminated study, Monetary Incentives and Work Standards in Five Cities: Impacts and Implications for Management and Labor (Greiner, Dahl, Hatry, & Millar, 1977).

In 1975, Columbia University was given a contract to study the operation of early retirement provisions in the 11-year contract between New York City newspaper publishers and Local 6 of the International Typographical Union. The resulting study, Printers Face Automation, (Rogers & Friedman, 1980) also covered printers' attitudes toward skill loss, their adaptation to new, lesser skill requirements and the impact of technological change on the union.

Also in 1975, LMSA provided funds to Lincoln Fairley for completion of a bibliography and the indexing of his voluminous study (1979) of the operation of the Mechanization and Modernization (M&M) Agreement between the Pacific Maritime Association and the International Longshoremen's and Warehousemen's Union, an agreement that was hailed as an innovative experiment in accommodating to technological change. Fairley concluded, however, that the M&M plan was more beneficial to the employers than to the longshoremen.

In 1978, LMSA provided funds to BLS to update its illustrative clause provision study of plant shutdowns, covering advance notice, interplant transfer, preferential hiring and relocation allowances. These provisions applied as much to the adjustment to technological change as to plant shutdowns.

In 1981, LMSA contracted for two studies dealing with labor-management cooperation. The first, a contract with Temple University, studied the operation of area labor-management committees and was published by LMSA (Leone, 1982). We also contracted with Cornell to study cooperative strategies for strengthening local communities and for shoring up failing companies. The result was a book, Worker Participation and Ownership (Whyte, Hammer, Meek, Nelson, & Stern, 1983), which has just been published by Cornell.

In 1981, our Assistant Secretary, reacting to the turn towards cooperative relationships in the industrial relations community, established a new Division of Cooperative Labor-Management Programs which is reaching out to participants, offering expert assistance.

Its activities inevitably brought a major shift in priorities within the Division of Research and Analysis towards labor-management cooperation, productivity and change, including technological change. In FY 1984, the Division expects a partial restoration of contract research funds lost under previous budgetary constraints and hopes for a greater improvement in FY 1985.

We are preparing for these new funds and we will be guided again by what is occurring in industrial relations and collective bargaining where significant changes are underway. These are occurring at the highest levels of unions and corporations (the strategic level of decisionmaking), in collective bargaining practices and outcomes, and at the workplace. There is a growth in cooperative processes, willingness by some unions to save economically distressed companies by making contract concessions and a willingness by some managements to open up decisionmaking to employee participation.

Research directions indicated by these events briefly are as follows:

1. We need to determine which of the changes are permanent and which are transitory and what the long-run impacts may be for cooperation and productivity.
2. We need to examine more closely the persistence of impediments to cooperation and change among workers, unions and managers, in order to provide data to decisionmakers seeking to cope with these problems.
3. We need to examine how cooperation and change has affected management and unions and what kinds of responses each has developed to cope with new situations. We are concerned with the evolution of institutions and their ability to cope flexibly with changes.
4. We have to examine the impacts of change, especially technological change, on workers and their jobs. This raises issues of job content, skill requirements, job satisfaction, job stress, worker earnings and job security, all of which are concerned with how workers cope as individuals.
5. Finally, we have to try once more to measure the effectiveness of cooperative efforts, an evaluation that has so far eluded researchers. A systematic approach would permit practitioners to follow their own committees and to adjust faltering committees as needed.

These, thus, will be LMSA's general research directions, examining productivity issues within the context of industrial relations. They mark a significantly greater involvement in productivity than in the past. The pace of the research will depend upon budget allocated to LMSA in FY 1984, 1985 and beyond.

Finally, LMSA hopes this symposium will act as a catalyst towards the formation of an information exchange network so that we can be aware of everybody else's research activities, can reach out to each other for advice and consultation and can explore areas of possible joint effort.

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PRODUCTIVITY RESEARCH IN THE DEPARTMENT OF DEFENSE

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Yes, there is a Department of Defense (DOD) Productivity Program! All one has to do is look through the subject index of DOD publications and you will find that DOD Directive 5010.31 carries this title. This is a broadly written document which touches upon the essential characteristics of the Department program. These are productivity measurement, enhancement, and evaluation. It is a classical approach. Measurement establishes a baseline, enhancement initiatives provide a means of improving productivity, and evaluation of results updates the measurement base and assesses the outcome of enhancement initiatives.

Approaches to productivity enhancement are grouped into three general areas within the program. These are operational improvement and resource determination, productivity enhancing capital investment, and work force motivation. While these enhancement approaches are identified as separate elements both in the DOD directive and supporting DOD instructions, they are, in fact parts of an interrelated approach to improvement. For example, one of the recent OSD POM (Program Objectives Memorandum) (budget) initiatives is the direction of efficiency reviews (operational improvement) of all support functions that are not subject to contract performance. Air Force, in a recent briefing on their efficiency review program, stated a need for productivity enhancing capital investment (PECI) funding to finance improvements identified during these reviews. The effect of the improvements upon the work force involved, as well as involvement of the work force in the review process, must also be a consideration in order to gain full potential from an efficiency review.

The Defense Productivity Program Office (DPPO) provides policy guidance and management for OSD. The program is managed through a network of principals in each service and agency and a subnetwork of program element managers (PECI/WFM (work force motivation)/Operational Improvement and Measurement). At the OSD level we are currently identifying productivity impact offices and program interrelationships in order to improve the OSD policy direction and information chains.

In the area of productivity research, DPPO is actively involved in internal research (staff-accomplished) or in managing contractor accomplished research. Internally we are working with the Naval Postgraduate School on incorporating sensitivity and risk analysis into the OSD major PECI and on the improvement of the DOD guidance on management of work force motivation efforts. With the assistance of the Naval Postgraduate School and a University of Maryland professor on sabbatical leave, research has been undertaken to correlate trends in the DOD manpower data base and productivity data. This attempt to correlate trends has thus far been inconclusive due to differences in data structures.

In the area of operational improvement and resource determination, DPPO has sponsored applied research in the development of a computer-aided

time standards system. This system provides for operational improvement through a network linking information bases across DOD. The time required to develop standards is reduced through the use of a computer to research data, calculate, print, and store the desired resource standard.

Another research project initiated by OSD, the analysis of the application of private sector incentive systems to DOD, is currently under DPPO management. In this project the characteristics of the most common performance-based incentive systems in the private sector were identified. These and the DOD experience gained in performance-based incentive systems (PBIS) experiments will be used to prepare guidelines to aid in DOD use of incentive systems.

During the next fiscal year the following topics will be proposed as subjects for additional research.

- Impact of quality circles within DOD
- Quantification of PECI potential
- Improvement in PECI selection process
- Determination of limits of work measurement cost effectiveness and development of application guidance
- Model work force motivation policy to improve effectiveness

The areas where future research could enhance the effectiveness of DOD productivity efforts are:

- Does concentration on quality result in increased employee commitment and ultimately improved productivity?
- What should the future direction of participative management in DOD be?
- What is the best method for introduction of new technology in the DOD environment?

RESEARCH NEEDS TO SUPPORT PRODUCTIVITY IMPROVEMENT EFFORTS
IN THE DEPARTMENT OF DEFENSE

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Office of the Assistant Secretary of Defense
(Manpower, Reserve Affairs, and Logistics)

The Department of Defense is facing an era in which budget requirements will far outstrip the amount of available funding. We are faced with options to do less or find ways to do with less through productivity improvement.

Defense has a policy that productivity improvement is everybody's business, and we are hoping to overcome the bureaucratic tendency that "when something is everybody's business, its nobody's business."

Dr. Lawrence Korb, Assistant Secretary for Manpower, Reserve Affairs, and Logistics (MAR&L), is interested in gaining a more comprehensive view of the relative level of effort of research and studies in the productivity improvement arena. This interest not only is prompted by internal DOD objectives to improve the efficiency of our operations but also is in response to national concerns. Indicative of that concern, the White House Conference on Productivity will be held this fall. The role of the research and development community in improving productivity is one of the central themes of this conference.

We've tried to satisfy Dr. Korb's questions regarding RDT&E's (Research, Development, Test, and Evaluations's) involvement in productivity issues. However, out of the \$23 billion dollar expenditure, we could find only \$2 to \$4 million targeted in this arena. Moreover, we later learned that that funding level had since declined by more than half as a result of Navy decisions.

We think there is more than \$2 to \$4 million being spent in productivity research; nevertheless, Dr. Korb put the question to the services in a June 6 memo. Both Dr. Korb and Jerry Calhoun, Acting Principal Deputy in the Office of the Secretary of Defense (MRA&L), strongly believe that we should identify research and study efforts on methods, strategies, and options for achieving and measuring manpower, training, and capital investment efficiency; and that we should exploit the results of these efforts in order to be more enlightened policymakers.

The responses to Dr. Korb's inquiry may direct us in many ways.

Service responses may in fact indicate that a lot is going on, in which case we will try to learn what we can and focus some effort in the thin areas.

Responses may indicate that not too much is going on. In this case we will evaluate strategies to generate additional focus on research and evaluation. Perhaps we could interest the Defense Science Board in the issue.

We believe the research and engineering (R&E) community has much to offer in this arena. We in defense need all the help we can get to stretch limited resources around expanding workloads. So don't hide your light under a basket, or let your insights be filtered out because they don't fit precisely-established information networks.

EDUCATION'S CONTRIBUTION TO PRODUCTIVITY

Edwin Dean
National Institute of Education

In 1981, NIE's Program on Education Finance began a program of research on education's contribution to productivity growth in the national economy.

The initiation of this research was motivated by concern for the decline in productivity growth and by the substantial body of research which concludes that education has been the source of a substantial portion of past productivity growth. For example, Edward Denison (1974, 1979) concluded that of the 2.4 percent average annual growth in national income per person employed, over the period 1948-73, education was the source of 0.5 percentage points. A residual of 1.4 percent was unexplained in Denison's analysis.

At the same time, economists recognized that the research methods used in the "growth accounting" literature and the closely related human capital literature were not free of problems. A number of difficult methodological and empirical problems had not been resolved (and are still not resolved). As one intriguing reflection of these problems, when Ed Denison completed his work for 1973-76, he found that the productivity growth rate had slipped to a negative -0.5 percent per year, while the contribution of education had risen to 0.9 percent. Meanwhile, the residual had become negative. Referring to his 1973-76 results as a whole, Denison wrote, "What happened is, to be blunt, a mystery."

NIE's research program was designed to contribute, in a modest way, to the understanding of education's role in productivity growth and to the examination of related difficult policy problems.

NIE-Sponsored Research

In one of a series of studies sponsored by NIE, Dale Jorgenson of Harvard University (1982) found that education accounted for almost one-fifth of the productivity growth over the years 1948-73. He also pinpointed some deficiencies in growth accounting as usually practiced: for example, it does not take account of the impact of education on the non-market activities of people employed in the labor market or on the activities of those not participating in the labor market.

Measurement of education's contribution to productivity growth is usually confined to education's effect on the quality of the labor input. Nonetheless, education can affect productivity through a separate influence on the rate of technological change. In another NIE study, Edwin Mansfield of the University of Pennsylvania (1982) explored the effects of education on the cost of generating technological change and the rate of diffusion of innovations. He concluded that current investments in education reduce the costs of technological change because they push the supply curves for

scientists and engineers to the right. He also presented evidence indicating that the rate of diffusion of innovations is positively related to the education of the personnel making the decisions about production techniques.

Robert Haveman and Barbara Wolfe of the University of Wisconsin (1982), noted that the standard approaches to measuring the economic benefits of education--the human capital and growth accounting approaches--yield partial measures of these benefits. For example, on the output side, these approaches focus on GNP or some other similar national income accounting measure. Haveman and Wolfe examined a broad range of positive (and a few negative) effects of education on economic well-being that are not measured through standard calculations of productivity. These include positive effects on children's nutrition, children's future incomes, and efficiency in consumption.

Finis Welch and Mark Plant of UCLA (1982) contended that the standard methods of growth accounting are a reasonable convention for simple measurement of factor contributions where outputs are well measured and where factor growth is exogenous. These techniques are less desirable for education and other forms of producer capital which are legitimately viewed as intermediate products. Welch and Plant proposed that we measure the contributions of intermediate inputs such as education by using tools similar to those used to analyze consumer's surplus.

In recent years, a number of researchers have suggested that Americans are being "over-educated." The returns to investment in postsecondary education, in particular, are supposed to have fallen relative to the returns to high school education. If this is the case, it is doubtful that continued expansion of postsecondary education is productive.

In a separate study, not yet concluded, Welch and Plant are subjecting this body of research to careful scrutiny. They are taking into account not only workers' education levels and ages, but also their amount of work experience, in their study of the returns to postsecondary education.

Unresolved Fundamental Research Questions

Scholars of the contribution of education to economic productivity have labored mightily, but without complete success, to resolve some fundamental analytical problems affecting this research field. Excellent reviews of these problems can be found in articles by Sherwin Rosen (1977) and Mark Blaug (1976).

Two of these persistent problems relate to the causal significance of the observed statistical link between education and earnings. First, it is quite difficult to determine the extent to which a correlation between people's abilities and their education attainments explains that link. Second, the "screening hypothesis"--the argument that the education/earnings link is explained by employers' use of education as a credential in hiring and promotion decisions--has not been definitively rejected.

Some researchers have attempted to measure the direct impact of education on productivity, without inferring this impact through examination of education's effect on earnings. Studies by David Wise (1975), of an automobile manufacturing firm, and by Stanley Horowitz and Allan Sherman (1980), of the productivity of ship repair workers, have been suggestive but far from definitive.

Two further research questions deserve comment even in a summary review. First, we need methods of measuring the productivity of educational institutions, and causes of changes in their productivity. The presentation of my colleague Gail MacColl includes discussion of this issue. We also need measures of the quality of education, so that "education" can be measured by variables other than numbers of years in school or earned certificates or degrees.

Unresolved Policy Issues

An economist interested in policies for increasing the contribution of education and training to economic productivity is likely to examine educational policy from the perspective of concepts such as efficiency, incentives, and the allocation of resources.

1. The National Commission on Excellence in Education has emphasized the issue of educational quality. The quality of education and the efficiency of our institutions are in all likelihood functions of the incentive structures faced by students, teachers, and administrators. NIE is currently preparing to sponsor a study of the role of economic and non-economic incentives in recruiting and retaining high quality teachers. We should also enquire into the reasons for the acquiescence of policymakers in high school graduation requirements that place little emphasis on mathematics and science: What roles, and why, have parents, students, and school personnel played in establishing the current requirements?

2. If high school systems were to place less emphasis on vocational education and more on basic skills, would high school students' future earnings be enhanced?

3. If specific job skills were to be taught increasingly by employers and less by educational institutions, would workers' productivity be enhanced? Would their future job mobility be adversely affected? Should tax policies encourage greater corporate training of employees?

4. As our economy becomes more and more technically sophisticated, will highly skilled personnel be produced in adequate numbers? (Ongoing work at the Bureau of Labor Statistics and the National Science Foundation addresses some aspects of this complex issue, but with little attention to educational policies, practices or institutions.)

Two words of caution are appropriate: First, while the goals of overall economic efficiency and higher educational attainment for low socioeconomic status students are sometimes compatible, it would be a

mistake to assume that this is always so. Second, specialists in the economics of education are sometimes tempted to exaggerate the degree of certainty attached to the conclusion that education and training make major contributions to economic productivity. They should be modest in their claims and the public should be wary of exaggerated claims.

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APPROACHES TO PRODUCTIVITY
IN THE STUDY OF ELEMENTARY AND SECONDARY EDUCATION

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Research on productivity-related issues in elementary and secondary education has taken a number of forms. Each has been concerned with the enhancement of learning, but from its own particular perspective.

Studies of instructional practice. Researchers concerned with learning, and with how to arrange instruction so as to foster student learning, have focused on the materials and processes of instruction. Curricular studies, concerned with what is to be taught and with ways of packaging skills and concepts so that they can be conveyed to students, form one branch of instructional studies. Of more concern to this conference, another branch has explored how these skills and concepts are best conveyed through the acts of the individual teacher. Studies of the act of teaching can be further divided into those that deal with teacher-learner dyad, and those that stress management of the classroom as a whole. For the most part, studies of instructional practice have treated the classroom as a self-contained unit, and have been conducted at a "micro" level, using experimental or observational data.

The search for determinants of educational outcomes. At the other end of the scale, a number of studies have sought to identify determinants of educational outcomes, based on aggregate, cross-sectional measures of student achievement and school, student, and teacher characteristics. Possible determinants have included student socioeconomic status, financial and other resources available to the school, class size, teacher qualifications, and teacher characteristics. These studies have demonstrated that student family background is a strong predictor of student achievement, but beyond that the results are generally inconclusive. Though the sophistication of studies of this kind has increased in recent years, the "black box" manner in which they treat the actual delivery of education has been much criticized.

"Effective schools" studies. Dissatisfaction with the apparent conclusions of educational outcomes research generated a number of efforts in recent years to identify "school effects" on outcomes. The prototypical approach in this class of study is to identify (on the basis of standardized achievement test scores) schools that appear to be doing substantially better than other schools with comparable student populations, and to poking about in such schools to see how they differ from negative outlier schools. Researchers have considered a broad range of possible contributors to school effectiveness, and this line of work has resulted in lists of factors of a mixed and general nature: effective schools are said to have clear achievement goals, an orderly climate, strong instructional leadership from the principal, an articulated curriculum, and so on. Nearly all studies have been conducted at the level of elementary education, and most have focused on schools with disadvantaged student populations. Their

findings, though not very precise, have become the basis for numerous school improvement efforts throughout the nation.

The emergence of the "effective schools" focus signals a growing realization that education is a collective endeavor. The individual teacher is critical to the process, but his or her effort is importantly shaped by the local institution in which teaching takes place, and by rules and policies from above as interpreted in the local context.

Schools as work organizations. A number of recent studies have abandoned the individual model of teaching, in favor of viewing the school as a work group. Such studies have suggested, for example, that schools in which teachers regularly interact around instructional issues and seek coordinated solutions to instructional problems are more effective than those that follow the traditional practice of allowing teachers to work in isolation from each other. Collegial interaction goes against professional norms, however; it needs active encouragement from the principal or other school leader, and is rendered more likely if teachers have been selected in a manner that fosters a disposition to collegiality.

Studies of the principalship. The emergence of "principal's leadership" as a factor in school effectiveness has prompted a number of investigations into the behavioral meaning of the term. Education has seen a number of time-use studies that demonstrate that principals' days are fragmented, highly interactive, and little devoted on the surface to matters of instruction. Researchers seeking to go beyond these findings have asked how effective principals define and convey educational goals for their school; find ways to reward able teachers and to deal with those who are not performing well; support teachers' efforts to improve; and buffer the instructional core by dealing themselves with discipline problems and parent and community demands. The question as to whether "instructional leadership" and "administrative management" are conflicting or compatible roles is currently the subject of considerable debate.

Again, studies have focused primarily on elementary schools. Such schools are generally small enough to permit frequent face-to-face interaction between teachers and the principal, and typically do not have additional hierarchical levels. The situation in a large secondary school is quite different, and research has only begun to explore what makes a productive school in a more complex setting.

Finally, there is research that grows out of concerns about policy. Education takes place in a context that is heavily policy-influenced. Matters that in a private organization might be determined by local management, such as the pay structure and employee selection and assignment policies, are heavily affected by state law and regulation and by contractual provisions. There is a growing body of research on the effects of collective bargaining (more precisely, of particular contract provisions) on the conduct of education: it includes both econometric analyses (e.g., of the effect of contract provisions on teacher time allocations), and observational studies.

Policy questions often gallop in advance of research that might bear on them, and education provides graphic examples of this. Assumptions about productivity underlie several types of legislation concerning teachers that are before states currently: competency testing laws designed to screen out the unfit, provisions for a mentored probation period for the beginning teacher, merit pay and "master teacher" proposals. Somewhat different assumptions underlie proposals for voucher schemes or tuition tax credits. The concern for principals' leadership is being translated into new schemes for testing and screening candidates for that position, and districts are beginning to build student performance more heavily into principal and teacher evaluation than heretofore.

The recently released report of the National Commission on Excellence in Education (1983, April), with its recommendations concerning time spent in school and its allocation, salary and career structures for teachers and the like, is likely to increase the demand for policy-driven research on school effectiveness or productivity. This will create both a demand for new studies and a need to translate into the educational setting established findings from productivity research in other sectors. Areas particularly likely to be addressed include:

- Studies of rewards and incentives in teaching, and their effects on retention and performance;
- Studies of means to improve teacher performance other than through incentives: for example, through in-service training, coaching or pairing of teachers, and increasing the degree to which instruction becomes a collective rather than an individual endeavor.
- Studies of performance change in school to suggest how poor schools can become better and what contributes to a school's decline. (There is a well-developed literature on change processes in schools, but it has grown out of an interest in the adoption of innovations rather than from a broad interest in productivity improvement.)
- Explorations of management support for effective education at the school and district level.

Finally, there may once again be a re-evaluation of the content of what is taught. Questions of content have been surprisingly inconspicuous in educational effectiveness studies to date.

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NAVY CIVILIAN PERSONNEL PRODUCTIVITY ENHANCEMENT

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The Navy Civilian Personnel Policy Division (OP-14) directly supports all areas of research, development, and studies (RD&S) pertaining to personnel management. These supported areas include, but are not limited to, efforts involving productivity enhancement. Within the RD&S arena, OP-14 coordinates and reviews, with advice and guidance from supporting agents, (i.e., the Office of Naval Research (ONR), the Navy Personnel R&D Center (NPRDC), the Research, Development, and Studies Branch of the Office of the Chief of Naval Operations (OP-115), the Center for Naval Analyses (CNA), and private contractors), various research projects pertaining to personnel management.

OP-14 utilizes the information, insight, and knowledge obtained from these projects in many ways. This information aids OP-14 personnel in formulating policy which may apply to all Navy civilian personnel. It is also used to respond to Congressional inquiries and other requirements imposed by various governmental agencies.

OP-14 is investing resources on several topical areas pertaining to productivity enhancements for the Navy civilian community. These efforts are grouped into six categories in order to provide some continuity. Although these groupings are somewhat artificial, there is a commonality which runs throughout, and all have some focus on personnel management.

Following is a brief description of the six areas and what OP-14 has done and is doing within each. There is also an indication of what types of efforts OP-14 believes should be researched or studied within each of the areas.

Manpower Issues

OP-14 is supporting several projects designed to assess the future requirements and future availability of personnel in selected critical occupations. Another effort, a "replacement cost" project, is currently underway; it is designed to ascertain the most effective way of obtaining journey level industrial engineers. The question is whether it is more efficient to hire these engineers at the full performance level or to hire trainees and provide career ladders for them.

System dynamics models are being developed to assess the impact of new policy or proposed policy changes on selected work force characteristics.

In addition, more research needs to be conducted in the areas of the "work force mix" (military/civilian/contractor) and the ability to successfully match people with suitable jobs.

Personnel Utilization

OP-14 is supporting a development effort designed to determine the most efficient size to provide high quality services for operating civilian personnel offices. This question has been asked many times: Is it more productive to have a large consolidated office servicing many employees or a smaller specialized office?

Future research needs exist in determining the most effective usage of the civilian work force. The concept of "cross-crafting" or "cross-training," especially in industrial settings, is a prime candidate for future research. Down time occurs because of the observance of "occupational specialities" within the highly unionized industrial settings of the civilian work force. Also, better methods for attracting and, more importantly, retaining women and minorities is an important issue at this time.

Performance Measures

In the past two years OP-14 has been heavily involved in two studies designed to identify the duties and responsibilities of Navy civilian managers. Survey and interview methodologies were employed to ascertain the important aspects of the managers jobs. These findings are being used to help develop better training plans, selection criteria, and performance standards.

A clearer understanding of the organization's value system would enable management to be more responsive to the needs of the total organization. Specifically, there is a need for more research in the measurement of "white-collar" and "managerial" performance. There is also a need to be able to measure performance on a "unit" or "organizational" level.

Employee Attitudes

In the past, several surveys have been administered to different subgroups of the work force in an attempt to determine the impact of the various policy and procedural changes (e.g., Merit Pay, Basic Performance Appraisal Plan (BPAP), pay caps) on employees' morale. Results from these efforts have been given to Congress for consideration while reviewing policy proposals. Results have also been given to operating civilian personnel offices to help facilitate the implementation of new changes.

Research needs to be conducted in areas which affect employee attitudes and thus the productivity of the individual. Some areas for investigation are: military-civilian relations, and the ability to provide the employee with a realistic job preview.

Governmental Policy and Programs

OP-14 has supported several projects which were designed to look at the effects of policy impacts on the work force. Studies were designed to

assess the effect the "pay cap" was having on Navy's ability to attract and retain top level managers. Results from these studies demonstrate that the productivity of the top level managers was rapidly decreasing because of the pay cap and other compensation issues. Findings from these studies were a major influence in the Congressional decision to lift the cap on executive salaries.

Several efforts are underway to model the movement of personnel in and out of the work force due to various proposed policy changes to the federal employees' retirement system.

Although OP-14 is very interested in how real and proposed policy changes influence the work force, there are many other areas which need attention. Some such areas are: how procedural constraints, compensation issues, and the image of the federal worker affect the productivity of the civilian work force.

Changing Technology

OP-14 adheres to the position that there are many technological advances which have the potential to drastically increase the productivity of the work force. However, there is much work to be done in demonstrating the "pluses" and "minuses" of the various techniques. More work needs to be done in the area of technological advances in industrial settings, in automated offices, and in computer assisted training. Research should provide management with guidance on the best level, mix, and type of technology and technique, if these "hardware" advances are to have the greatest impact.

Conclusion

OP-14 is very supportive of efforts within the productivity arena. However, in the past, OP-14 has always been in a reactive mode: that is, mainly investing resources in response to an immediate problem. Dealing with research issues in this manner makes it difficult to obtain a focal point or continuity between the various efforts. Sensing the need for continuity, OP-14 initiated a major effort to establish a master research, development, and studies plan. A contractor is in the process of determining the immediate- and long-term research and studies needs for OP-14. This document, or "roadmap," will identify the various areas in which research or studies should be done to enable the managers in OP-14 to perform their duties more effectively. The roadmap will establish a priority or order for the conduct of various projects and demonstrate how one project ties in with, or is related to others. Upon its completion, OP-14 will have a clearer understanding of exactly what types of efforts to invest resources in for the best payoffs. This will enable OP-14 to be less reactive and more proactive in the area of research. The projected completion date for the roadmap project is 1 May 1984.

PRODUCTIVITY RESEARCH AT THE
NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER

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Introduction

The Navy Personnel Research and Development Center (NPRDC) has had a program area of research specifically devoted to the topic of productivity since 1975. This program area began with small projects limited in scope and has gradually expanded to larger scale undertakings. It is the purpose of this presentation to describe what we have found as a result of this research to date, what we plan to do in the future, and, most importantly, what we can conclude regarding leverage points for improving federal government productivity. In other words, what kinds of organizational and behavioral changes are most likely to bring about significant productivity improvement in the federal government?

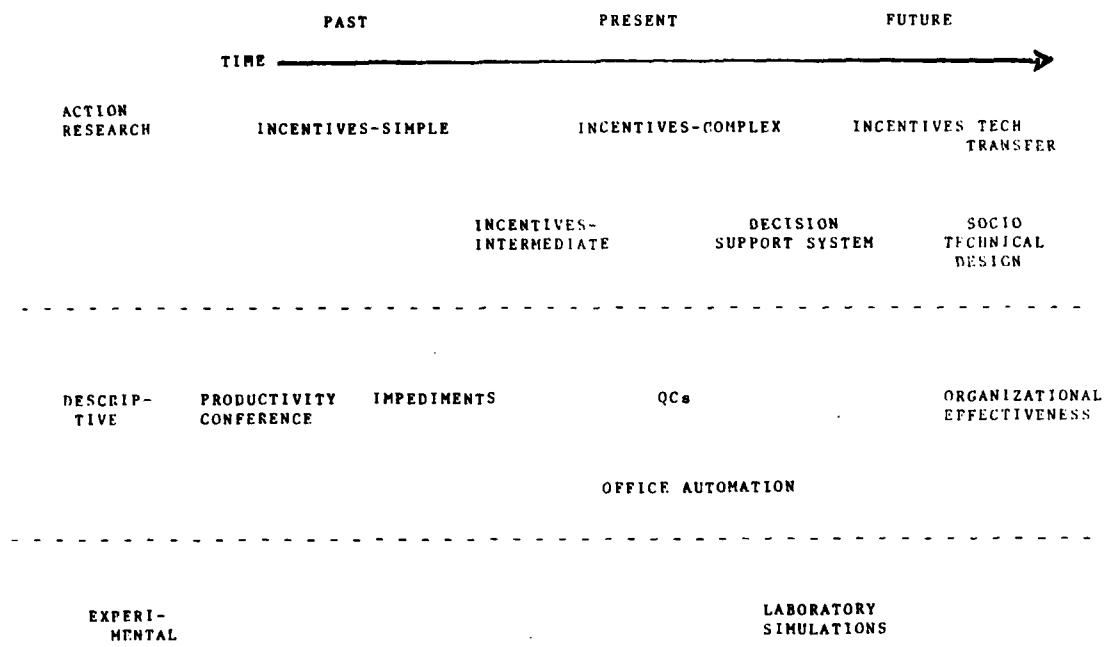
We began our research in organizations in the Navy's shore support establishment and have continued to work in this community ever since. Within this community we have focused the large majority of our efforts on logistics, industrial types of organizations such as shipyards, air rework facilities, public works centers, and supply centers. These organizations are staffed almost entirely by civil service employees of the Navy. Only their top management positions are filled with naval officers. As a result, we have had considerable experience working on productivity issues with the civil service population--experience which has generalizability to the rest of the federal sector.

Summary of Projects

The figure summarizes our major projects as well as a few of our plans for the future. The figure differentiates our research projects into three types: action research (i.e., interventions), descriptive research, and experimental (laboratory) research. The following summarizes each of our projects:

1. Study of incentives and gain-sharing, usually in conjunction with feedback and goal-setting. This has been a whole series of research tasks, ranging from an individual system for a simple job (key entry operators) to individual systems for more complex jobs (supply clerks, mechanics) to a group system for complex jobs (machinists). This work is being extended to new locations; and other types of incentives, such as performance appraisal, will be tested. The primary conclusion is that incentives are very effective in improving productivity provided they are installed in places that meet certain criteria and provided they are properly implemented and managed.

MAJOR PRODUCTIVITY R&D PROJECTS AT NRPDC



2. Conference on military productivity in 1978. Identified productivity as an important concern, delineated the major problem areas, and suggested solutions in these areas.

3. Study of impediments to productivity in the Navy's industrial community. These were subdivided into two types: non-personnel-related (e.g., not receiving parts in a timely fashion in order to accomplish repairs or maintenance of weapons systems) and personnel-related (e.g., difficulty in hiring qualified people in a timely manner). A large number of external constraints were identified that make it difficult for employees to be highly productive.

4. Study of the effects of quality circles (QC's). This was a one-year longitudinal evaluation in four organizations. Findings: The QC's did solve problems but the cost benefit data typically available were not adequate to make a good evaluation. The QC's did not, however, improve attitudes of the QC members toward their jobs or organizations. Also, the overall organizational climate (particularly top-down communication patterns) militates against QC's, which are bottom-up communication.

5. Study of new technology. A large amount of high technology is suddenly being introduced into the Navy's shore establishment. An analysis of this trend showed that little consideration is being given, in advance, to how best manage personnel and design organizations to insure full utilization of this technology. In recognition of this, we have two projects in this area.

a. Factors affecting successful implementation of office automation. This recently completed project identified critical factors, such as proper training and a statement from top management regarding their goals for the new technology.

b. A quality-enhancement approach to improving productivity in a highly automated facility. This recently initiated project will be done in the Naval Integrated Storage Tracking and Retrieval System (NISTARS), which is a highly automated material handling facility being introduced into Navy supply centers. In one such facility we will design and implement a decision support system and organizational structure. These will operationalize the approach of improving productivity through improving quality. The approach is based on the work of Dr. W. Edwards Deming (1982), who uses a statistical approach to improving quality and productivity; this approach is widely employed in Japan. The results of this intervention in terms of improved productivity will be evaluated using an action research methodology.

6. Laboratory experiments and simulations. A new laboratory is under development which will make it possible to run well-controlled experiments of various simulated organizational conditions. For example, one experiment has already been run to determine the optimal sharing rate for gain-sharing systems between the organization and employees. Findings from the lab can later be field-tested for external validity.

7. Study of organizational effectiveness (OE) of Naval Air Rework Facilities (NARFs). This project, just beginning, is aimed at determining what dimensions account for NARF OE, and then what organizational factors and management practices affect OE. This may result in the design of a decision support system for headquarters to manage the NARF community.

8. Study of sociotechnical design. This is a project we would like to undertake in the future. It would be similar to the intervention the Army recently completed at Corpus Christi Army Depot. The key to improving productivity in this approach is that employees at lower levels in the organization participate heavily in the organizational analyses and design, thus developing a strong sense of ownership and commitment.

Conclusions

On the basis of the overall experiences and findings from our productivity research program to date, I have concluded several things about where the most leverage exists for productivity enhancement in the federal government. In terms of the types of research to be done:

1. It should be primarily action research, only to be supplemented by descriptive research.
2. We should concentrate on research which ties organizational factors to bottom-line output, i.e., productivity. This in turn necessitates continued attention to what constitutes productivity and organizational effectiveness and how to measure it.

3. The scope of the intervention, or preferably multiple interventions, should be sufficiently large that it will change the corporate culture and/or organizational climate and thus result in permanent organizational change.

In terms of the types of change to be made, while it depends on the situation, in general the following have the most leverage:

1. Interventions which focus directly on management rather than the work force.
2. Interventions which decentralize decisionmaking.
3. Interventions which increase work-force participation.
4. Interventions which improve quality at the appropriate points in the work process.
5. Interventions which create information systems which support the four points above.

My overall conclusion is as follows:

1. We already know a great deal about the problems influencing productivity.
2. We already know quite a bit about the solutions to these problems, that is, ways to improve productivity.
3. We know relatively little about how to implement these solutions, that is, how to gain acceptance, to implement, to gain support, and, most importantly, to change corporate culture so that permanent institutional change will occur. If we can increase our understanding in this area, quantum productivity improvements in the federal government are attainable.

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PRODUCTIVITY RESEARCH IN THE NAVAL MATERIAL COMMAND

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The Naval Material Command (NMC) defines productivity as "an attribute of organizational performance characterized by the relationship between the products of the organization (goods, services, ideas) and the resources applied (labor, material, time, money, etc.)." The transformation of applied resources to products is a process in which are manifest such factors as quality, quantity, timeliness, cost, and utility.

The NMC has as its capstone productivity objective "the enhancement of the performance of its organizations in support of the fleet." Specific performance objectives include a 5 percent per year increase in both blue and white collar measured performance for the next five years, and the explicit inclusion of productivity factors in the Navy resource allocation decision process.

The NMC productivity program, which supports the aforementioned view of productivity and the resultant set of objectives, has five basic components: (a) capital investment, (b) quality of work life, (c) organization and management, (d) process design and work engineering, and (e) performance measurement. Projects and initiatives directed towards institutional performance are interactively coordinated by program management responsibility in each of the basic component areas. This guarantees that all facets of a productivity problem are synergistically addressed; this in keeping with the Navy view that productivity is a systems issue.

The NMC productivity research program is supportive of the program outlined above. Specific focus to date has been on projects in technology transfer, incentives, organization design, disassembly/assembly systems, and impediments identification and addressal. Major thrust areas for future human factors research include organization design, technology adaptation and transfer via sociotechnical systems techniques, man-machine systems optimizations, and large scale incentive systems. In each area, prevention of sub-optimization and formal program/project interaction are dealt with explicitly in the multicomponent Navy approach, the net result being an integrated, additive research program supporting specific enhancement objectives.

Whenever possible, the action-research approach will be utilized in future research activity. The NMC favors this approach, which, when combined with descriptive research technique, yields a full-cycle embedded and functioning result rather than merely a report. It thus becomes easier to export research results across Navy institutional boundaries, and the spread of research results is much more rapidly obtained. Also, the action-research approach allows fine tuning in a real-world, normative environment and facilitates the addressal of all five components of the NMC program in each project undertaken.

PRODUCTIVITY: RESEARCH PROBLEMS, APPROACHES AND PAYOFFS

Bert King
Office of Naval Research

In this paper, I will give you my thoughts on: (a) some of the problems and issues involved in behavioral and social science research on productivity, (b) which approaches and substantive areas deserve emphasis, and (c) what some of the payoffs are, or might be.

One major problem or issue has to do with the definition of productivity and whether we delimit this term to the ratio of outputs to inputs or whether we extend the definition to something closer to "effectiveness" or "efficiency." To what extent should we take into account, not just the number of units produced but also absenteeism, personnel turnover, industrial sabotage, etc.?

A second major problem is the dearth of robust theory in the area of productivity. The manager or researcher who wants to increase productivity in a work group or an organization as a whole would be hard put to find an adequate theoretical framework that could tell him whether, for example, to change his selection and training procedures, his capital investments, or his pay schedules. Such an individual would also find an extremely confusing literature in which, on the one hand, many researchers report that job satisfaction does not relate substantially, if at all, to productivity whereas others stress the necessity of doing various morale-building things which in some way would ultimately influence the effectiveness of the organization.

Another complication is the fact that different disciplines have focused on different variables and cross-references tend to be scarce. Economists, not surprisingly, have looked intensively at wages and financial incentives; sociologists at ways of organizing work; engineers at robotics; and psychologists at abilities, personnel selection, and motivation. There is, unfortunately, little guidance available on how we put all these variables together in a single conceptual framework. What this amounts to is that we don't really know whether we should first manipulate financial incentives, the image of the organization, its leadership and management practices, or what.

A related problem is the fact that the bulk of the actual field experimentation that has occurred has been pretty much limited to industrial organizations. Even when clear-cut findings emerge with respect to such organizations, we would be engaging in an act of faith if we assumed the results would be the same in commercial organizations employing service workers (e.g., an insurance company), much less in academic organizations, research laboratories, government offices, or military units.

Measurement problems constitute another problem area, since laboratory experiments seldom come close to replicating the complexity of real-life organizations and field experiments or studies seldom have adequate

controls for extraneous variables. In an actual organization, it is difficult to measure the productivity even of a single worker in a manner which permits one to specify what that worker's contribution to productivity is, because the typical employee depends on others or on allocation of resources by management for his/her input. When we go to the level of the work group or the organization as a whole, the situation becomes infinitely more complex due to possible interactions of human factors, equipment availability, competition/cooperation within and between groups, etc. All too often we look only at a fraction of the extant data and settle for a crude measure of productivity which has not been purified of extraneous elements.

Another major problem concerns the lack of adequate evaluations of the results of productivity-improvement efforts. There are several reasons for this, including, of course, the difficulty even in making causal attributions, much less assessing the benefits of changes. In addition, many social/behavioral researchers have as their objective hypothesis-testing rather than making or recommending decisions on the actual practices of organizations. However, there are a few encouraging signs of increased interest in the social/behavioral sciences in analyzing what happens in complex real-life change projects. One model of such analyses is the recent ONR-sponsored book by Paul Goodman and L. Kurke (1982) in which they attempt to account for the success (or lack of success) of the major quality of worklife projects that have been completed. I'll say more about that later.

A final problem or issue for some of us is that of the role and contribution of the behavioral and social sciences in the area of productivity. I think a case can be made for the fact that our contributions may have been underestimated--perhaps because our findings and achievements don't have the glamour of, say, robotics or CAD/CAM. As an example of well-deserved recognition of the importance of social and behavioral science, I would like to cite a recent Science editorial (Zuiches, 1983) which referred to an AAAS colloquium, ("R&D, High Technology, and Economic Recovery") which provided justification for the Reagan administration's 1984 R&D budget. Questions were raised in the colloquium by personnel from the Office of Science and Technology Policy and from the Office of Management and Budget which dealt with fundamental issues on the supply and training of personnel, ways of organizing work groups, the transfer of basic research from the laboratory to industry, and the possible job-creating effects of high technology. "Not all the participants in the colloquium, however, seemed to recognize the social scientific nature of these questions and the research efforts needed to understand the conditions conducive to technological innovation and the likely consequences of such change" (p. 779).

Recent hearings in Congress on "The Human Factor in Innovation and Productivity" (1982) yielded an encouraging appraisal of the importance of the variables dealt with by behavioral and social scientists:

The testimony presented during these hearings attested to the critical role that human factors play in the realm of productivity and innovation. The witnesses also indicated the lack of

integration of the human element in decisionmaking in this area. Much attention has been focused on the R&D, tax, financial, and regulatory aspects of increasing the innovative capacity of the United States, but little attention has been focused on the utilization of human resources to accomplish this. Among the quoted remarks were: "Human resource development is the least understood factor affecting productivity performance and . . . in the long term, perhaps the most crucial." "All too often, . . . the importance of people in the process is undervalued and underestimated. This has contributed to the declining productivity of the U.S. workforce" "The primary contribution to productivity and innovation in American society is the human factor and it is a requirement for social innovation to create that productivity" (pp. 19-20).

Let's turn now to a consideration of approaches to the improvement of productivity that show promise at the level of the individual, the work group, or the organization. At the level of the individual, the first approach I would mention is that of the selection of workers. Hunter and Schmidt (1983) state that the use of valid selection tests of ability can result in productivity gains (i.e., labor savings) of as much as \$15 billion per year in the U.S. Government and \$80 billion or more in the U.S. economy as a whole.

While comparable meta-analyses have not yet been carried out for training programs, it would be anticipated that substantial gains could be realized here, too. Hunter and Schmidt (1983) state: "Utility analysis of the results of existing reviews suggests, however, that the economic value of many such programs will prove to be large. The combined effects of selection and nonselection interventions can be expected to produce increases in workforce productivity that are large indeed" (p. 473).

A number of studies of individuals have dealt with learning and reinforcement paradigms. Among the most impressive of these are the so-called behavior modification experiments. In behavior modification, one tries to change the individual's behavior by selectively reinforcing certain responses. Luthans (1981) has summarized the results of organizational behavior modification programs in firms including Emery Air Freight, Michigan Bell, GE, Sohio, and others. Generally speaking, these results show that cost savings can be directly attributed to the behavior modification programs, that productivity increased, and that other benefits accrued (e.g., safety and attendance improvements).

Related to behavior modification but even simpler conceptually is the phenomenon called goal setting. Locke, who has gained international recognition in this area, has conducted basic research for ONR in which he measured the effects of goal setting. In an ONR technical report which subsequently was published in the Encyclopedia of Management (1982), he summarized the literature as follows:

In the last eleven years alone there have been over 100 published studies on the effects of goal setting on performance in both laboratory and organizational settings. In 90% of the

studies goal setting was found to be effective in improving task performance. This makes it one of the most effective and reliable motivational techniques known. The average goal setting program in an organizational setting achieves a 16% improvement in task performance; some achieve much more. In combination with money incentives, goal setting has been found to achieve performance improvements in excess of 40% (p. 364).

At the level of the group, there is a plethora of laboratory experiments on the effects on work group performance (productivity, quality, etc.) of independent variables like group composition, leadership, communication networks, etc. Unfortunately, many of these experiments cannot be generalized easily to real-life work groups since the latter differ so much from the lab groups in variables like the importance of the group, the history or lack of history of the group, the importance and size of the incentives manipulated, etc. Certainly one of the crying research needs in this area is ways of enhancing the generalizability to the work world of laboratory experiments on groups.

One of the problems in looking at real-life work groups is that the group is embedded in an organization, which gives rise to a number of interaction effects across the group and organizational levels. In other words, it is difficult to look at work groups without taking into account organization-level phenomena. One group-level effort that I will discuss next is that of groups that adopt a specific goal of increasing their productivity and work quality. Such groups are widely referred to as "quality circles," and this phenomenon has burgeoned to the extent that there are a number of professional associations composed of people who sponsor and/or do research on quality circles. Cole (1979) goes as far as to state that quality circles are one of several factors which have helped Japan in its phenomenal productivity increases. In recent research done for ONR, Harper and Jordan (1982) examined the impact of quality circles and found that 500 U.S. companies have adopted quality circles. We don't yet know, however, the extent to which quality circles work in the different organizational and cultural settings in the U.S. To what extent, for example, is the success of the Japanese quality circles attributable to the associated organizational and cultural variables like lifetime employment, extensive educational programs for employees, industrial democracy, and the absence of a history of unionization and intense labor-management conflict? Obviously, we need much more research under controlled conditions to answer such questions.

At the level of the organization, we need to consider the attitudes, motivation, and behavior of top managers. One recent, provocative study came up with the thesis that American productivity problems arose because American manufacturers lost the determination to manufacture well (Abernathy, Clark, & Kantrow, 1983). They find that American automobiles became more or less standardized and that "innovative" activities consisted of minor tinkering with body styles rather than engineering and/or styling changes in the interests of greater efficiency. Their recommended strategy is "dematurity": consciously striving for substantial innovations as well as increases in productivity and quality.

Other researchers have also delved into American productivity problems. One of our ONR researchers--Bill Ouchi--compared Japanese and American organizations and identified three major styles: a Japanese style, an American one, and a third style which characterized the best managed organizations, whether Japanese or American. He christened this efficient style "Type Z," by which he meant to designate a new style that should supersede the practices earlier described by McGregor as Theory X and Theory Y. Ouchi is currently conducting for ONR the largest investigation to date of all the American and Japanese electronic and aerospace firms in an attempt to determine which objective indices relate most highly to their productivity.

Several other recent books written for a general audience contain diagnoses and prescriptions for our productivity maladies. Peters and Waterman (1983) draw on a study by McKinsey and Co. and identify eight managerial attributes found in the most successful companies. These include participative management, minimal hierarchical distinctions within the organization, and autonomy for managers. The problem, of course, is that we don't know which of these variables might also exist in less effective companies. In addition, insufficient attention is paid to: (a) what goes on at the organization's interface with other organizations, (b) the extent to which social and technological changes might have accounted for the success of a given organization, (c) the relationship of the organization to the climate of opinion within its country with respect to labor-management relations and the degree of competition or cooperation with other companies and with the national government and its regulations governing antitrust activities. Ouchi's current ONR research will put us in a better position to answer such questions, since it examines relationships of the organization with other organizations (e.g., suppliers) and with the national government.

Another topic receiving considerable attention in research circles has now reached the popular press: that of "organizational culture," which refers to the attitudes, beliefs, norms, and practices that prevail in a given organization. Deal and Kennedy (1982) maintain that successful American companies motivate employees by establishing an environment that stresses the use of rituals, folklore, and rewards. At ONR we are currently examining the utility of the concept of organizational culture. Under our sponsorship, Edgar Schein and John Van Maanen of MIT are examining corporate culture in both industrial settings and paramilitary organizations. With them, we are also currently discussing with top Navy managers the extent to which these concepts might help us understand better the productivity of Navy civil servants as well as Navy families who live abroad.

What can we reasonably expect in the way of productivity increases when we institute productivity programs? The results are encouraging, and a recent review by Katzell and Guzzo (1983) of 207 American productivity experiments over the last 11 years using one or more psychological approaches indicated that 87 percent of them reported an increase in at least one index of productivity. Forty-six out of 50 interventions (92%) using training variables resulted in productivity increases; 21 out of 22

(95%) using goal setting produced gains; 18 out of 20 manipulating financial compensation (90%) resulted in improved output. The least impressive results--and even these were pretty good--resulted from changed work schedules; here 11 out of 18 programs (61%) increased productivity.

I would like to conclude this presentation by giving some recommendations for future research on productivity.

1. Certainly we need substantially more research on productivity. More basic research involving concepts, theoretical frameworks, and models is needed which will include a wide range of variables and is not restricted to the level of the individual or the group. Applied research is needed in field settings in which we experiment, as much as possible, under controlled conditions with substantial numbers of cases.

2. More research is needed with a long-term point of view as opposed to taking a snapshot at one point in time. Adequate longitudinal research designs would put us in a much better position to make causal inferences than the typical one-shot manipulation of a single variable that prevails in the literature.

3. We must look at the process of productivity as opposed to merely scanning the bottom line. In other words, we need to know how whatever effects come about were produced, what the mediating mechanisms are, and what the management process is.

4. It is imperative that we find new, more effective ways of organizing work--ways which elicit the best efforts of both labor and management. As we proceed into the era of robotics and automation we need to devise new patterns of management. Scientists at a recent computer conference stated that "seventy-five years of management ideas must be discarded if industry is to get high productivity out of factories run by computers," according to an article in The Washington Post ("Old Management Notions," 1983). Seymour Melman, according to the same article, stated that "the effects of trying to computerize the workplace without changing outmoded notions of how to manage a factory can be disastrous." He cited the example of two nearly identical factories building engines and transmissions. In the factory which had trained its workers in computer programming and given them authority to control the computerized machine tools, an efficiency level of 97 percent was attained. In the other factory, in which machine tools are locked up so only managers can change them, the efficiency level was at 50 percent of capacity.

5. We must find better ways of building trust in the organization on the part of workers. Ouchi, of course, has stressed this factor as a characteristic of the effective organization--whether Japanese or American. At the operational level, Ford administration labor secretary William J. Usery, who is now a labor advisor to the joint-venture company proposed by GM and Toyota, said recently, "We're talking about building a whole new workplace. . . We've got to change old attitudes. Presumably, if we have a union and we get a contract, we're going to get a relationship based on mutual trust instead of hatred" ("Old Attitudes," 1983).

6. In order to elicit the best efforts of workers, we must find new and better ways of increasing participation in decisionmaking. Ed Lawler, who is currently conducting ONR research on measuring and rewarding successful job performance, observed recently (personal communication, June 21, 1983) that the current productivity efforts in industry involve two not unrelated trends. One involves increasing communication upward as in quality circles. A second trend involves a more direct attempt to foster increased participation in decisionmaking by reducing the number of managers and of hierarchical levels to arrive at a "lean and mean" organizational structure.

7. More multidisciplinary research is drastically needed. Both the behavioral sciences and the information sciences, for example, should be highly involved in automating factories, offices, and ships.

8. We must pay additional attention to obstacles to productivity programs in particular and to organizational changes in general. This is not a new topic, but it deserves renewed attention in the context of the organizational ferment that characterizes the United States at present. At ONR, we are just starting up some new basic research on organizational obstacles of this nature under the direction of Ben Schneider at the University of Maryland.

Finally, we need to know more about the institutionalization of change, which is the process that occurs when one tries to convert an experimental program into part of the standard operating procedure of an organization. Unfortunately, Paul Goodman, in his ONR research, has found that the success rate of planned change effects, when judged by the hard criterion of persistence over time, is low. On the basis of a comparison of successes and failures of planned organizational change, Goodman and Dean (1982) have proposed a model of institutionalization that includes five processes, which are in turn mediated by the structural properties of the organization and by the specific changes involved. They have also provided 18 hypotheses which can be used to predict the success or failure of institutionalization efforts. These hypotheses provide part of the technology base for any future programs we try to implement.

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Appendix A

ONR Symposium on Productivity Programs and Research

Marriott Hotel Key Bridge
Arlington, Virginia

8:30 a.m. - 4:30 p.m.
June 27-28, 1983

PROGRAM

Monday, June 27

<u>AM</u>	Chairperson: Dr. Bert T. King
8:30	Keynote address
	Professor Herbert E. Striner American University
9:30	National Science Foundation
	Dr. Louis Tornatzky Productivity Improvement Research
10:15	BREAK
10:30	U.S. Army
	Mr. T. Jack Nickerson Mr. Thomas S. Siciliano Materiel Development and Readiness Command Dr. Paul P. van Rijn Army Research Institute
11:15	National Aeronautics and Space Administration
	Mr. David Braunstein Productivity & Quality Enhancement
12:00	LUNCH
<u>PM</u>	Chairperson: Mr. Robert A. Sniffin
1:30	General Accounting Office
	Mr. Stephen L. Morgan Accounting and Financial Management
2:15	U.S. Air Force
	MAJ Rodger D. Ballentine Dr. Charles N. Weaver AF Human Resources Laboratory MAJ Robert Ginnett Yale University
3:30	BREAK
3:45	U.S. Department of Labor
	Mr. Leon E. Lunden Research & Analysis, Labor Manage- ment Services Administration

Tuesday, June 28

<u>AM</u>	Chairperson: Dr. Alan W. Lau	
9:00	Office of the Secretary of Defense	Mr. Richard J. Power Defense Productivity Program Ms. Karen C. Alderman Civilian Requirements & Analysis
9:45		BREAK
10:15	U.S. Department of Commerce	Mr. Thomas Dunne Management Systems, National Bureau of Standards
11:00	National Institute of Education	Dr. Edwin Dean Educational Finance Program Ms. Gail S. MacColl School Management and Organizational Studies
12:00		LUNCH
<u>PM</u>	Chairperson: Mr. Forrest C. Gale	
1:30	U.S. Navy	Ms. Dorothy Meletzke Civilian Personnel Policy Dr. Laurie A. Broedling Navy Personnel R&D Center Mr. Forrest C. Gale Productivity Office, Naval Material Command Dr. Bert T. King Psychological Sciences, Office of Naval Research
3:30		BREAK
3:45	Wrap-Up	Professor Striner
	Discussion	All Participants

Appendix B

ONR Symposium on Productivity Programs and Research

ROSTER

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